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LOGISTICS PLANNING AND LOGISTICS PLANNING FACTORS FOR HUMANITARIAN OPERATIONS

by

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LOGISTICS PLANNING AND LOGISTICS PLANNING FACTORS FOR HUMANITARIAN OPERATIONS

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ABSTRACT

Due to the increasing demand on the military to conduct humanitarian operations, the need for logistics planning factors that are applicable to these operations has arisen. This thesis develops a model for humanitarian operations and employs the model to develop logistics planning factors for material consumption and a computer-assisted planning aid relating to the support of the victim population.

THESIS DISCLAIMER

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

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EXECUTIVE SUMMARY

In the past 30 years, the Services have assisted in over 300 humanitarian operations in over 60 different countries and yet humanitarian assistance has historically failed to be designed a primary or secondary mission of the Services. This has resulted in a lack of cohesion among the operations. Each operation has been conducted independently of the others. Although today's technology allows the lessons learned to be studied, there is very little known regarding the consumption rates experienced when assisting civilian populations. Many documents state that the current logistics planning factors for military operations should be used to support the victim population. Unfortunately, these planning factors do not adequately address the needs of the populations being supported as illustrated by shortages and excessive stockpiling that are continually experienced by the Services when conducting humanitarian operations. The shortfalls have required costly airlifts to avoid disaster while the stockpiling has resulted in tons of supplies being destroyed. In these days of dwindling funds, these logistical errors consume thousands of dollars that could be better spent elsewhere. A sound logistics planning model can reduce the amount of guess work incurred by the planners, produce a reliable planning tool for all humanitarian operations, and thereby help to preserve funds.

This thesis develops a model from which logistics planning factors for materiel consumption can evolve. The model is based on the origin of the disaster that resulted in the Services' rendering assistance and the five major variables that have been incorporated into the model. The scope of the model is limited to the direct support of the victim population. The variables that have been included in the model are the location of the operation, demographics of the population to be supported, the physical condition of the population to be supported, the condition of the infrastructure, and the duration of the operation. Each variable directly affects the materiel requirements necessary to support these operations. Once all the variables have been defined the logistics planning factors can be calculated using the formulas and baseline logistics planning factor that are derived and described in this thesis.

In order to develop credibility in the eyes of the planners, the development of the logistics planning factors is described in detail. The planning factors developed in this thesis only include the basic requirements necessary to support the recipient population. If additional supplies not considered by this model are required, the detailed explanation of the derivation will also help the planners alter the logistics planning factors to accommodate the special needs that have arisen in the planning process. Finally, to further facilitate the use of the planning factors developed in the thesis, a computer-assisted planning tool was developed. The program allows the user to input the variables that relate to the operation they are supporting and provides the user with the appropriate planning factors. The program eliminates the need for the planner to learn the calculations and provides the planner with limited contingency planning capabilities.

Finally, this thesis attempts to validate the planning factors that were derived. Data was collected amidst Operation Sea Signal in Guantanamo Bay, Cuba. The actual consumption rates were compared with the planning factors computed by the model. Although the data was not sufficient to thoroughly validate the model's planning factors, the results of the analysis present a startling correlation between the model's output and the actual consumption rates experienced during Operation Sea Signal.

I. INTRODUCTION

A. BACKGROUND

> Suppose a brother or a sister is without clothes and daily food. If one of you says to him, "Go, I wish you well; keep warm and well fed," but does nothing about his physical needs, what good is it? James 2:16.

Long before this country became a nation, humanity has sought to help those less fortunate than themselves. Because of our society's desire to assist those in need, the United States military has historically come to the aid of nations in peril. The break up of the Soviet Union has hastened this philosophy as our country truly assumes the role of the Superpower and expands the mission of our military beyond its normal capacity. Today, our military is called upon to execute a variety of contingency operations that have become known as Operations Other Than War (OOTW). These operations include peace-keeping, noncombatant evacuations, rescues at sea, refugee assistance, and emergency relief operations.

In many cases, the main mission of OOTW is humanitarian assistance. The *Doctrine for Joint Operations* states that humanitarian assistance is a program designed to relieve or reduce the results of natural or man-made disasters. Interestingly enough, humanitarian assistance has historically failed to be designated a primary or secondary mission of the Armed Services. [Ref. 1: p. 34] However, the Goldwater-Nichols Department of Defense (DOD) Reorganization Act of 1986 gave humanitarian operations a higher priority by designating them as "special operations activity." [Ref. 1: pp. 34-35] Today, humanitarian assistance is designated as a collateral activity of Special Operations Forces by "the virtue of their inherent capabilities." [Ref. 2: p. II-12] Humanitarian operations were designed to be supplemental to the efforts of the host nation, civil authorities or other agencies; and, they were originally intended to be limited in scope and duration. However, our Services are now tasked to sustain these operations for extended

periods of time and in many cases as the principal provider. For example, the aid provided to the Kurds in Operation Provide Comfort is now well into its third year. Furthermore, Operation Sea Signal which is supporting the Haitian and Cuban Refugees in Guantanamo Bay, Cuba is certainly not supplemental in nature. In fact, the United States is the primary source of support for this ongoing operation. As the scope, duration, and responsibilities of these operations expand, the Services' original definition of humanitarian assistance is obsolescent.

There is a great deal of political debate on the applicability of using forces, whose primary goal is to protect our country from hostile nations, to feed the needy. As the debate continues, each Commander in Chief/Unified Combatant Commander (CINC) has been directly tasked to budget, defend, and protect humanitarian/civic action funds in their Program Objective Memoranda. [Ref. 3: p. 3] This has left the CINCs in a precarious position as they have found themselves financially responsible for actions for which they have no specifically designated mission. As a result, the doctrine for humanitarian operations is developing slowly and the taskings have been conducted in an ad hoc fashion. Unfortunately, lack of coherence and guidance does not stop the floods, famine, or strife throughout the world or the tasking of the Services. Instead, lack of coherence among the operations creates an obstacle for planners as they are forced to develop strategic and logistics plans without the benefit of the planning and decision making tools currently available for traditional missions. Humanitarian operations are, by their nature, very complex and can be extremely taxing to a Commander and his staff. With the proper tools, a Commander can be afforded the benefit of lessons learned from past operations when developing his strategic plans and the logisticians will have a logical place to begin the initial assessment of the mission's needs. However, planning tools, other than mission specific operations manuals, designed to assist Commanders in planning for OOTW are not readily available.

Logistics is a common denominator in all humanitarian operations. The basic problem is relating the employment of operating military forces and the requirements for supporting dependent populations to the utilization of logistics resources. The problem is usually addressed with the development of logistics planning factors or consumption rates. The planning factors are normally based on experience or usage data from previous operations and they provide planners a satisfactory baseline for logistics planning. Unfortunately, the ad hoc manner in which humanitarian operations have been conducted has failed to accumulate the necessary data to create suitable planning factors for humanitarian operations. Further, the manuals currently available for traditional military employment such as the Army Field Manual 101-10-1/2, "Organization, Technical, and Logistical Data Planning Factors," or the Navy "Logistics Reference Data" are proving to be inadequate for the conditions experienced during humanitarian operations. The inadequacies are seen when repeated shortfalls and excesses can not be avoided from operation to operation. The discrepancy between what is required and what is delivered directly affects the CINC's budget and has created a general interest in the development of suitable planning factors. Traditional derivation techniques analyze operational data while making concessions for current policy. Unfortunately, operational data and policy are limited so other ways to derive logistic planning factors need to be considered. A very viable option is to analyze documented histories from both military and civilian relief agencies to determine the broad aggregation of logistic requirements and which items will be decisive or critical to the operational readiness of humanitarian operations.

B. THESIS MOTIVATION

The motivation for this thesis stems from the difficulties encountered by the staff of the Commander in Chief, Atlantic Fleet (CINCLANTFLT) in supplying and sustaining emigrant operations in Guantanamo Bay, Cuba. During the first six months of the operation, the logistics personnel realized that the logistics planning factors currently in

use by the Services do not adequately address the special needs encountered when supporting civilian populations. For instance, the needs of infants and children are not considered in any of the military manuals on planning factors. Since the manuals were designed to determine the needs of the Services during traditional operations during both peacetime and wartime, it is understandable that infants are not included. However, with the rapid transition to Operations Other Than War, a very large void is emerging that if unaddressed can become quite an obstacle for our logistics planners to overcome. A lack of sound decision making tools forces planners to guess what is required to complete the missions successfully.

In the past the planners' guesses, although well thought out, have failed to encompass the scope of the operations. Drastic shortages in critical items have required costly airlifts to avoid disaster. Excess stockpiling of items deemed critical has resulted in huge losses due to spoilage, waste, and a variety of other damage. Excess expenditures are also incurred when cultural norms and population demographics are not considered. The miscalculations are costing the taxpayers millions. Further, these operations are not yet fully funded by Congress or the Host Nations, so the Services are forced to reallocate scarce training dollars to ensure the success of the contingency operations they are tasked to execute. In spite of fiscal supplements exceeding three billion dollars in FY 95, these operations are rapidly consuming training dollars which directly affects the overall operational readiness of our forces. Strategically, operational readiness is of utmost importance to our military leaders so there is a great deal of interest in reducing the expenditures incurred by these contingencies. A sound logistics planning model can reduce the amount of guess work incurred by planners and thereby help to preserve training dollars.

A second motivation is the need for rapid response. Historically, OOTW require immediate response, rarely allowing for the timely planning process to occur. For instance, how often are planners privy to the onset of an earthquake? Earthquakes are a type of natural disaster that can result in a large number of injured and displaced persons.

These people need food, shelter, and medical care. In many cases, individuals may be left in life-threatening situations and even a single day spent planning could result in the loss of life. The speed in which assistance is rendered can greatly influence the success of the mission. Logistics planning factors and an organized means to access them can help simplify the planning process thereby reducing the time necessary to successfully assess the mission's needs. Furthermore, planning factors can standardize the material requirements for these contingencies which will allow planners to predict the needs of current and future operations.

C. OBJECTIVES

The object of this thesis is not to develop a "how to" manual for Humanitarian Operations but to develop a methodology or model from which planning factors for material consumption can evolve. The scope is limited to direct support of the victim population. Although not specifically addressed by this thesis, the importance of material readiness for the forces should not be understated. However, it is believed the existing logistics planning factors can adequately address the needs of the military personnel. With this in mind, there are three main objectives of this thesis and they are summarized as follows:

1. Methodology

The first objective is to develop and document a methodology for constructing and organizing planning factors for humanitarian operations. In essence, the methodology encompasses creating the structure for a model concerning humanitarian operations. First, a means to classify the variety of contingencies that require humanitarian assistance is developed. Each possible option is described briefly to provide the details of the various scenarios to the logisticians. The categories that are omitted are discussed as well as the rationale for their disqualification. The model is then partitioned with respect to the variables that are regularly encountered when planning for humanitarian operations. The

specific variables discussed include geographical location, demographics of the recipients, physical condition of the recipients, duration of the operation, and the remaining infrastructure. The variables are defined to ensure the differences between the operations are identified and to remove any ambiguity in the terminology. Finally, cultural norms will be discussed to make the distinction between variables that affect the quantity of supplies needed and variables that affect specific item ordering which will explain why the later will remain independent of the model.

2. Logistics Planning Factors

The second objective is to develop Logistics Planning Factors for Humanitarian Operations. The development includes two stages: a construction phase and a validation phase. The construction phase discusses the actual derivation of the multipliers for the different classes of supply. The methodology used is based on argumentative reasoning rather than quantitative analysis so the multiplier may be specified as range of possibilities rather than a single number. There are two reasons for this methodology. First, the method is more simplistic which encourages a better understanding of the derivation and it produces believability and credibility in the model. Second, there is a lack of accurate and consistent raw data from humanitarian operations which makes using traditional data analysis techniques to derive the figures extremely difficult. Furthermore, if data were available, the resultant figures would be too mission specific to have any application in the large number of operations that may need to be evaluated.

The construction phase points out all the basic assumptions behind the development of the planning factors as well as the applicability of the various classes of supply to humanitarian operations. In some cases, the traditional units of measure are replaced to make the multiplier more responsive to the mission at hand. Unfortunately, the uncertainty surrounding planning is difficult to include in the model so inconsistency will still need to be compensated for by the logisticians. Every effort has been made to point out the inconsistencies so that planners recognize the critical areas and can compensate appropriately. Finally, since the multipliers are derived from historical studies

and lessons learned rather than raw data, a brief study of the applicability of the methodology and the developed planning factors will be conducted to enhance the confidence that logisticians will have in the numbers.

During the validation phase, the model's output is compared with actual data compiled from the operations in Cuba. The data collection process is discussed. The discussion includes the identification of the assumptions regarding the data and the inconsistencies found in the data. The major discrepancies between the model's output and the data are identified as well as the associated causes.

3. Computer Assisted Planning Tool

The final objective is to develop a computer assisted planning tool that incorporates the methodology and planning factors derived in this thesis. The system will serve two purposes. Foremost, the program will provide a user friendly interface between the logistician and the planning factors. In many cases, the derivation of the planning factors can be difficult for some individuals to comprehend. Furthermore, thumbing through manual after manual to find the scenario that accurately depicts the mission at hand can be extremely time consuming. This system will eliminate the need for the planner to comprehend the derivation of the factors or to thumb through stacks of manuals. The logistician will be able to "click" his way to an appropriate scenario and quickly compute his material surge and resupply requirements. With the initial needs in hand, the planner can quickly design a mobilization strategy.

Secondly, the program will be a planning tool for future operations The program is not intended to identify the specific mission needs but rather to predict the materials quantities that are required at the onset of a contingency. As a predictive model, it can explore the range of contingencies and provide a basis for contingency and prepositioning planning. Once a Task Force is assigned, the advance party can assess and augment the program for mission specific details that will be beneficial to future Commanders handling similar operations.

The development of model and the methodology is explained in Chapter II. Chapter III explains logistics planning factors to the reader. In addition, Chapter III contains the derivation of the planning factors while Chapter IV contains a limited validation (or verification) of the planning factors developed in this thesis. The details of the computer assisted planning aid are contained in Chapter IV. The final Chapter contains concluding remarks as well as suggestions for further research on the subjects of logistics planning factors and humanitarian operations.

II. MODEL STRUCTURE

A. HISTORICAL PERSPECTIVE

A quick review of some of the more recent humanitarian operations the military has participated in will provide an opportunity to analyze any similarities and differences surrounding these operations. The goal is to introduce the reader to the variety of operations that are currently classified as humanitarian operations by the military while identifying the lack of a unified plan for these operations. Unfortunately, many of the specifics surrounding these operations, especially regarding population demographics, are still classified so many of the numbers are estimates based on the studies of the recipient populations. To develop a plan, a structure that can adequately encompass the spectrum of operations is needed. By studying past operations, the consistencies can be used to support the model's aggregated structure. The differences can then be incorporated into the model as variables to provide the required flexibility and adaptability needed for a truly robust model. With this in mind, six recent humanitarian operations are presented as background for the development of the model's structure that will follow.

1. Operation Provide Comfort, 1991

To overpower the rising Kurdish independence movement that began in early March 1991, Saddam Hussein began a series of brutal attacks against the Iraqi Kurdish population. The Kurds, who were unable to withstand the Iraqi troops and feared Iraq's formidable chemical arsenal, fled into the mountains of Northern Iraq and Southern Turkey. By April 3, the Kurds were no longer an active resistance. The area the estimated 750,000 Kurds and their families fled to was a rugged, mountainous area, without any supporting infrastructure, that experiences bitterly cold temperatures due to the elevation. The Kurds were homeless, weak, and lacked adequate food, clothing, and water. The public outcry was overwhelming. On April 5, 1991, the United Nations

Security Council passed U.N. Resolution 688 condemning Iraq for its repression of the Kurds and appealed to the member states to provide relief to the Kurdish refugees. [Ref. 4 : p. 7]

Under intense international and domestic pressure which was spurred by the media, President Bush tasked the DOD to provide humanitarian relief to the Kurdish people. The Commander in Chief, U.S. European Command responded quickly as deployments for Operation Provide Comfort started the next day and the first relief supplies were air dropped within 24 hours. The initial mission of the combined task force (CTF) was to feed the Kurds and reduce their suffering by providing short-term delivery of supplies. However, the Iraqi government's reluctance to allow the relief effort to continue as well as the absence of civilian relief organizations forced the mission to be expanded. The expanded mission included the sustainment of the entire refugee population until the civilian relief agencies could respond. The support was to include food, water, medical care, the set up and organization of refugee camps, and to improve sanitation. The CTF was forced to extend this mission further as the civilian relief organizations and the United Nations High Commission for Refugees in particular took much longer than expected to become involved. On July 17, the U.N. High Commissioner for Refugees assumed responsibility for the humanitarian relief effort and the CTF was redeployed. In the end, Provide Comfort was credited with delivering 17,000 tons of relief supplies using the combined efforts of 12,300 U.S. and 10,900 coalition forces. [Ref. 5 pp. 19-22]

Unfortunately, this would not end U.S. involvement. On July 17, the operation entered a new phase, Operation Provide Comfort II. The mission of this operation is to maintain the secure area in Northern Iraq and Southeastern Turkey so that non-governmental organizations can continue to provide humanitarian assistance to the Kurds. [Ref. 6: p. 22] To this day, the Kurds and the Iraqi have been unable to resolve their political differences and United States European Command is still actively participating in Operation Provide Comfort II.

2. Operation Sea Angel, 1991

On April 29, 1991, cyclone Marian hit the South east coast of Bangladesh. Winds were more than 235 KPH and tidal surges were between 15 and 20 feet. The Bangladesh government estimated that 139,000 people and over a million cattle died. [Ref. 7: p. 2] Furthermore, the infrastructure was destroyed. More than a million homes were destroyed or damaged, leaving the occupants without shelter. Chittagong, the major port, was rendered non-operational, key bridges were washed out, sea walls collapsed, jetties disappeared, dirt roads were flooded, and most of the transportation was destroyed. To further complicate matters, the Bangladesh government was young and inexperienced. Although the government had adequate relief supplies, it was unable to successfully distribute the supplies due to the poorly developed and otherwise damaged infrastructure. Even when the stores were brought to Chittagong, the Bangladesh Navy was unable to distribute the items to the islands that were in great need of support because many of the Navy's ships had been sunk by the storm and effectively blocked the port. [Ref. 7: p. 3-4] On May 10, the U.S. Ambassador formally requested military assistance.

On May 10, 1991, the President directed the U.S. military to provide humanitarian assistance to Bangladesh. The operation began on May 12 and became known as Operation Sea Angel. After the initial disaster relief survey teams performed the disaster assessment, LtGen. Stackpole developed a plan that dealt with the political instability as well as the disaster. His plan consisted of three phases: Phase I entailed delivering food, water, and medicine to reduce the loss of life; Phase II was to restore the situation so that the Bangladesh government could take control of the relief efforts; and, Phase III was the turn over to the Bangladesh government and the withdrawal of U. S. troops. [Ref. 8: p. 114] One of the elements that made this operation a success was minimizing the number of forces on Bangladesh soil. This was accomplished by establishing sea based support. The primary concerns of the forces were rapid administration of medical support and the production and distribution of water. The major stumbling blocks of the relief effort were the lack of infrastructure and the resulting effects on distribution.

The population of Bangladesh is approximately 120 million with a large growth rate. The large population is believed to be the primary reason for the high death toll incurred by the storm. The high growth rate also provided the logisticians with some interesting problems as nearly half the population is under the age of fifteen. Furthermore, the calorie consumption per day is less than 2000 with the main staple being rice. To complicate matters more, only 44 percent of the population has access to safe water. Finally, the potential for medical disaster was real, because the fresh water sources had been contaminated and thousands of dead bodies lay unburied.

The operation spanned just over 4 weeks, delivered approximately 4,000 tons of supply by air, 2,000 tons by Landing Craft Air Cushion (LCAC), over 266,000 gallons of water were produced by Reverse Osmosis Water Purification Units (ROWPU), and 7,000 Bangladesh citizens were provided medical treatment. [Ref. 9]

3. Operation Provide Hope, 1991

As the Soviet Union collapsed and the Commonwealth of Independent States (CIS) began to emerge, the former republics began having trouble establishing independence from their former economic policies and Moscow. The dependence on the government led to the possibility of much of the population starving during the winter of 1991-1992. As a result, the United States Air Force , under the Denton Space Available Transportation Program, airlifted 230 short tons of food and medical supplies to St. Petersburg, Moscow, Minsk, and Yerevan from 17 to 22 December 1991. [Ref. 10: p. 11] It took an additional six weeks before the Joint Chiefs of Staff would issue the order to execute Operation Provide Hope. The mission of this operation was not to feed the entire CIS population but rather to get essential food and medical supplies to the hospitals, orphanages, community shelters, retirement homes, schools, and other charitable agencies. [Ref. 10: p. 11] U.S. troops were not involved in administering aid during this operation. In fact, very little was known about the recipient population other than the they were hungry and ailing. The Services were essentially responding to the requests of the CIS's, charitable organizations. The country representative receiving the property was

responsible for its distribution. [Ref. 11: p. 2] The main goal of the operation was to transport aid to distribution centers. To accomplish this task the operation was conducted in two phases. The first phase involved airlifting the supplies into the theater and the second phase involved the use of CIS ground transportation to deliver the supplies to one of the 33 designated locations inside the CIS. The airlift portion of the operation was conducted by the Air Force while a few Army personel directed ground movement. Very few U.S. forces were on the ground in the CIS; yet, during the operation, lasting from 10 February until 1 August 1993, more than 7,012 short tons of food and medical supplies were delivered. [Ref. 10: p. 12]

4. Operation Provide Promise, 1992

This operation was established to counter the effects of the Yugoslavia Civil War. This war began when Yugoslavia started its transition from communism to democracy in 1991. During this period, several provinces, including Bosnia - Herzegovina, declared their independence. Religious differences fueled a great deal of the strife as the three major players, the Roman Catholic Croats, the Orthodox Christian Serbs, and the Muslim Bosnians, fought for dominance. By April 1992, the U. S. and much of the European community had recognized the independence of Bosnia. Unfortunately, a successful cease-fire had not yet been accomplished and the Serbian militia continued their relentless and brutal efforts to "cleanse" Bosnia - Herzegovina of Muslims. The women were raped, and the men and boys were put into concentration camps. The fierce fighting had destroyed the capital, Sarajevo, and was causing severe shortages of food, water, fuel, and medical supplies. [Ref. 10: p. 16] More than two million people had fled the province and about 140,000 were missing -- presumed dead. The campaign of terrorism and genocide had already taken its toll on Bosnian demographics. Some estimates reflect reductions in the Muslim populations as high as ten percent with proportionally high shifts in the population's make-up as the men were being killed by the hundreds. Those that had managed to survive were scared, homeless, hungry, and in many cases injured. On May 14, 1992, the Joint Chiefs of Staff authorized the release of excess food and medical

supplies, including 80,000 pounds of Meals, Ready to Eat (MRE), to the United Nations High Committees on Refugees. Almost two months later, on July 3, 1992, the order to execute Operation Provide Promise was issued to United States European Command. [Ref. 12: p. 82] The mission was to act as the U.S. agent for humanitarian support to the U. N. and to plan airlift relief operations into Sarajevo. The operation was able to deliver over 42,843 tons of food and medical supplies in spite of the extensive damage the fighting had caused on the infrastructure. [Ref. 10: p. 17] For the duration of the operation, the U.S. remained as an agent to the U.N. and did not attempt to assume mission responsibility. However, in response to increasing refugee needs, the U.S. started an airdrop mission late February 1993. Though 27 March 1994, 16,916 tons of food, 159 tons of medical supplies, and 485 tons of weather protection material had been airdropped into Bosnia. [Ref. 10: p. 18-19]

5. Florida, Hurricane Andrew, 1992

On August 24, 1992, Southern Florida was struck by Hurricane Andrew. The storm killed at least 26 Floridians, damaged or destroyed 85,000 Dade County homes, and shut down uncounted businesses. Further, the storm paralyzed the infrastructure, especially the power distribution grid. Although physical injuries to the victims were minimal, thousands of families were left homeless and hungry. A week later 625,000 people, the pumping station for the water supply, and the waste treatment plants were still without electricity. [Ref. 13: pp. 8-9] Within three days of the storm, the Federal Emergency Management Agency (FEMA) tasked the Department of Defense to provide disaster assistance. Joint Task Force Andrew (JTFA) was established to set-up feeding sites, supply food kitchens, store and distribute supplies, set-up temporary housing for the homeless, conduct cargo transfer operations, and provide any other logistical support required by the local population. [Ref. 14] This operation also consisted of three phases: Phase I, the relief phase, provided immediate relief consisting of food, water, shelter, medical, sanitation, and transportation; Phase II, the recovery phase, sustained phase I while assisting the government to reestablish public services; and, Phase III, the

reconstitution phase, continues the re-establishment of services under the control of non-DOD agencies while the JTFA redeployed. Luckily, the damage to the transportation infrastructure was limited to downed power lines and traffic signals so the flow of relief items into the affected communities was not hampered. [Ref. 13: p. 9] The operation lasted just over three weeks and included over 23,000 military personnel. During the operation over 1,000,000 meals ready to eat (MRE's) were served, over 2,800 tents and 54,000 cots were set up, and medical care was provided to over 48,000 people. [Ref. 14]

6. Operation Restore Hope, 1992

The problems in Somalia began in January 1991, when General Mohammed Siad Barre, the country's current ruler, was forced to flee the country by the warring factions that were attempting to overthrow the government. In the next two years, approximately 300,000 people would be killed by fighting, disease, or starvation. By the summer of 1992, more than 65% of Somalia's citizens were on the brink of starvation. [Ref. 15: p. 6] The effects of malnutrition began to manifest quickly due to the fact that over 50 percent of Somalia's population is under the age of 15. [Ref. 16: p. 76] The already staggering infant morality rate increased and many diseases associated with the malnourished, like dermatitis and chronic anemia, began to emerge. To make matters worse, the government and the supporting infrastructure ceased to exist, eliminating the possibility of the children receiving government sponsored medical care or aid.

There was a great deal of political debate regarding the employment of the U. S. military to administer humanitarian assistance in regions with no government. While the debate ensued in early 1992, the media focused on images of the starving Somalis. UNISOM, the U.N.'s attempt to lead a humanitarian mission with the U.S.'s involvement (named Operation Provide Relief) was a complete failure. The relief efforts were poorly planned, had no identifiable support system, and the Somalis were still starving. On December 9, 1992, with the public support of America, 25,000 Marines went ashore in Mogadishu and took control of the operation the U. S. named Restore Hope (the U. N. name for this operation was UNITAF). The goal of this operation was to establish a

secure environment and start the aid by providing assistance to the humanitarian relief organizations. The operation covered 40 percent of the country's land mass, created eight separate and secure humanitarian sectors to distribute assistance, and delivered more than 37,305 tons of supplies. [Ref. 15: p. 14]

On May 5, 1993, the Security Council took control of the operation, now named UNOSOM II. However, this was not the end of U.S. involvement. To ensure a smooth transition from one operation to the next, Joint Task Force Somalia (JTFS) was created. The mission of JTFS was to underwrite the operation as a Quick Reaction Force and to provide the initial logistics support. As of March 31, 1994, 91,295 tons of supplies were delivered into Somalia. [Ref. 10: p. 14] Although the operation was deemed a success once the U. S. took control, the lack of infrastructure as well as the difficulty surrounding the coordination of non-governmental relief organization was a continual source of problems.

B. CLASSIFICATION OF DISASTER

The historical perspective indicates that humanitarian assistance is rendered for many reasons. However, a more extensive literature review suggests that humanitarian operations are executed to counter the effects of disasters. There are many types of disasters each one is unique in its own right. Because of the unique distinctions in the various disasters, their material requirements differ which makes logistics planning more difficult. To simplify the planning process, it would be helpful to classify disasters with common effects. Once the types of disasters are classified, the planner can more readily assess the requirements that are constant and those that have a tendency to vary. The highest level of classification can be attained by determining the underlying cause to the disaster. Was the disaster caused by nature or was it caused by man? Unfortunately, not every disaster will fall neatly into one category so planners must use their discretion when categorizing an unusual disaster. As a general rule, the logistician tasked to determine the

material requirements for the relief operation should consider the main source of the destruction, rather than the underlying cause. For example, a broken dam that floods a neighboring valley is a man-made disaster yet the effects resemble a natural disaster. In this case, the population will need immediate assistance recovering from the flood damage while repairing the dam becomes a secondary priority. Therefore, it would be classified as a natural disaster.

A more comprehensive discussion of the natural and man-made disasters as well as the categories used to break down the types of man-made and natural disasters are discussed below and they are summarized in Table 1.1.

1. Natural Disasters

A natural disaster is associated with the destruction incurred as a result of natural phenomena. Natural disasters have been in existence since the birth of man and any number of texts document the thousands of lives these disasters consume every year. These disasters encompass a variety of specific types of calamity. Again these disasters can be classified based on the origins of their destructive nature. There are four categories of natural phenomena. The categories are meteorological disasters, topological disasters, telluric and tectonic disasters, and biological disasters. [Ref. 17: pp. 1-2]

Meteorological disasters are the result of atmospheric disturbances; or, in layman's terms, these disasters are a result of the weather. There are four categories of weather induced disasters: storms, cold spells, heatwaves, and droughts. Storms include cyclones, hailstorms, hurricanes, tornadoes, typhoons, and snowstorms. Each type of storm has the potential to destroy everything in its path. Cold spells and heatwaves, on the other hand, tend to concentrate their damage on a single commodity usually agriculture or livestock. Although an unexpected freeze could quickly reduce a citrus crop and a heatwave could destroy the poultry industry, no documented cases of humanitarian assistance being rendered by the military as a result of these drastic temperature swings was found. The final weather induced disaster is a drought. By definition, a drought is a long period with little or no rain. Like cold and heat waves, droughts affect our agriculture and livestock.

However, in Third World or impoverished nations, a drought can be the prelude to many other disasters like famine and disease; in which case, the destructive potential is unlimited and the probability of military relief being rendered in these areas is very high.

The remaining categories of natural disaster are the result of natural phenomenon other than the weather. Topological disasters occur as a result of the physical features of a region. For instance, mountainous regions experience avalanches while valleys are prone to flooding. The three most prevalent examples of topological disasters are avalanches, landslides, and floods. Telluric and tectonic disasters deal with the earth's structural deformation. They include earthquakes, tsunamis, volcanic eruptions. The finally category of nature disaster is biological disasters. Examples of biological disasters include: insect swarms and epidemics of communicable disease.

It is important to remember that the destructive nature of a natural disaster is dependent on the disaster's proximity to population centers, the state of disaster preparedness, and the duration of the disaster. If a blizzard occurred in the middle of the tundra, it may not even be noticed. However, an earthquake in the middle of Los Angeles does make the headlines. Further, today's superior technology allows some natural disasters to be predicted. This is particularly true concerning meteorological disasters. Unfortunately, knowledge of an impending disaster can not stop the destruction. Advance knowledge does provide the planners and future victims alike the opportunity to execute evacuation plans or prepare appropriately for the onset of the calamity.

2. Man-made Disasters

A man-made disaster is the result of mankind's self destructive tendencies. As the name implies, these disasters are caused by people or their creations. There are three main categories of man-made disaster. The categories are civil disturbances, warfare, and accidents. [Ref. 17: p. 10] Civil disturbances can range from a demonstration to the fall of a government. Civil disturbances also include unrest resulting from economic or social instability, both perceived or actual. The results of civil disturbances can have severe consequences as the country's citizens may flee to a more stable country. Warfare

disasters are the result of armed conflict. Recent history shows that most warfare disasters requiring military assistance are the result of a country or people fighting for independence. No matter what the cause of the hostilities, warfare disasters take their toll on the local population. The suffering the people endure is remarkable and the media plays a big role awakening the conscious of the American public. In many cases, the military is brought in to ease the suffering of the citizens of the warring countries. In other cases, the people do not wait for aid; instead, they actively seek assistance by migrating to another area. There are three common types of warfare employed that can be used to further categorize these disasters: conventional, non-conventional, and guerrilla. Any war that uses traditional war fighting techniques, bombardment, blockade, and siege, can be classified as conventional warfare. Nuclear, biological, and chemical (NBC) warfare is an example of non-traditional warfare. The use of irregular military forces that employ harassing tactics against their enemies, like terrorists, can be categorized as guerrilla warfare.

The next category is accidents and it is divided into four parts: transportation disasters, structural disasters, fire disasters, and technological disasters. Train crashes, plane crashes, and sunken ships are all examples of transportation disasters. They all are linked because they involve a mode of transportation. Structural disasters, on the other hand, are caused by the failure or destruction of a made-made structure like a building, bridge, or dam. Fire disasters are the result of the destructive nature of fire and smoke. Technological disasters are the result of failures or mishaps with the technical innovations of the day. A leak in a nuclear power plant, the dumping of hazardous chemicals, and oil spills are all examples of technological disasters. Again, Table 1.1 summarizes all the types of disasters, their origins, and provides examples for each category.

Type of Disaster	Origins of the Disaster	Examples
Natural	Meteorological	Storms Cold Spells Heatwaves Droughts
	Topological	Avalanches Landslides Floods
	Telluric and Tectonic	Earthquakes Tsunamis Volcanic Eruptions
	Biological	Insect Swarms Epidemics
Man-made	Civil Disturbances	Demonstrations Governmental Collapse
	Warfare	Conventional Non-conventional Guerrilla
	Accidents	Transportation Calamities Structural Damage Fire Disasters Technological Failures
After: Ref. 17: p.10-11		

Table 1.1. Summary of the Types of Disaster Included in the Model

C. PHASES OF RELIEF

Since the immediate need for relief supplies causes logistics to be the driving factor in humanitarian operations, it is critical for the logistician to determine when the supplies can be delivered. A working knowledge of a disaster's cycle will identify critical time lines for supplies and allow planners to establish shipment dates for impending operations which will reduce delays. Unfortunately, there is no definite sequence of events that will occur

as a disaster runs it course. However, most disasters do appear to cycle through a series of phases. This model includes six distinct phases. Although the Services historically render assistance only in the last three of the six stages, each phase and its logistical concerns will be addressed to reduce ambiguity.

1. Warning

The time between notification of an impending disaster and the actual onset of a disaster is identified as the warning phase. The type of disaster and the ability to predict its occurrence affect the duration of this stage. For example, the chance of predicting a transportation calamity or an earthquake is very small; therefore, the warning phase of these disasters could go undetected. Conversely, the chance of predicting a hurricane or a drought is very high; therefore, the warning phase will have an identifiable duration. During the warning phase, logisticians are provided the opportunity to plan for possible contingency operations and the potential victims are provided the opportunity to prepare for the impending calamity. The additional planning time afforded when this stage is present has the potential to reduce the need for crisis planning should the disaster require military intervention later. This is because the logistician can begin an assessment of the anticipated victim population and begin analyzing the material requirements and transportation alternatives should aid be needed.

2. Impact

The impact stage is identified by the actual occurrence of the disaster. For example, the time a hurricane is actually ravaging a coastline or the time refugees are actually fleeing their homeland are both examples of the impact stage. Again, the duration is dependent on the type of disaster occurring. The impact stage of an earthquake lasts only a few minutes while the impact stage of a drought can last months. Unlike the other stages of a disaster, every disaster that occurs will enter this stage. Unfortunately, there is very little that can be done for the victims during this stage; however, planners can wisely use this time to prepare for the possibility of assisting the victims in the near future.

3. Decision to Intervene

During this stage, the decision as to whether or not U.S. Forces should be used to aid the victims is made. This phase usually occurs after a disaster has run its course; however, when a disaster has a very long impact stage, like famine, this phase could overlap the impact stage. The affected area's outside communications are limited during this stage so the victims must help one another until communications can be established and outside relief can be obtained. That is, the victims are essentially isolated from the world around them because no outside assistance has been afforded to them. This phase is highlighted by the heroic measures individuals summon to rescue others from life-threatening situations. Like the impact stage, there is little that relief workers can do to assist the victims until communications can be established and the decision to provide relief is made. However, if there is a high likelihood that the Services will intervene, the planners can continue the contingency planning they began in the earlier stages of the disaster. In some cases, the decision to provide relief has already been made but can not be executed until aid is requested by the recipients. For example, before Operation Sea Angel, our country was fully aware of the devastating cyclone that had hit Bangladesh, but until the Bangladesh government asked the U.S. government for assistance nothing could be done.

4. Relief

This stage begins when organized assistance reaches the victims. The stage is designed to help the victims get their lives back in order and is intended to be short in duration. This is the first stage where military assistance can be rendered. The victims basic needs are the primary concern as they are provided food, clothing, shelter, and medical care as appropriate. The military's mission is established in the Chairman of the Joint Chiefs of Staff executive order. [Ref. 18: p. 6-24] The logisticians must support the mission requirements.. To support the mission, the logistician has to assess the needs of the victims, their unique cultural requirements, and the infrastructure available to receive and distribute aid. Without prior knowledge of the operating area or the victim

population, this job can be very taxing. To make the assessment process easier, the CINC can send an advance party from his staff to survey the recipient population's composition, the disaster's damage, and to determine any unique operational requirements. If time constraints preclude an advance party, the logistician is forced to rely upon current literature or diplomatic disaster surveys for background information.

5. Sustainment

The sustainment phase is an extended relief phase. The victims do not or can not regain their "normal" existence; they depend on the aid exclusively. More often than not, this stage is seen when administering aid to refugees or victims of prolonged famine. Although this stage can be recognized in a variety of operations around the globe both past and present, there is no documented evidence that this stage has ever been identified. This phase is unique to this model. It is identified because distinct logistical problems arise from the victims' dependence on aid. Low morale of the victims and providers, quality of life of the victims, and funding are major obstacles of this phase. Logisticians primary concerns are replenishment, replacement of worn items, quality of life items, and personal demand items of those being supported.

6. Restructure

This is the stage where the victims begin rebuilding their lives. When the Services are involved in this stage it is known as civic action. Civic action has existed as a distinct mission of the Services since World War II, is carefully pre-planned and is usually carried out by Army civil affairs units or Navy Seabees. [Ref. 19: p. 6] Although the logistical concerns of this phase are immense, policy and guidance for civic action operations have already been established so further details will not be included in this thesis.

D. FACTORS AFFECTING HUMANITARIAN AID

Since the onset of a disaster is essentially unpredictable, modeling the possibilities and analyzing the needs of potential victims of various disasters will ensure rapid response

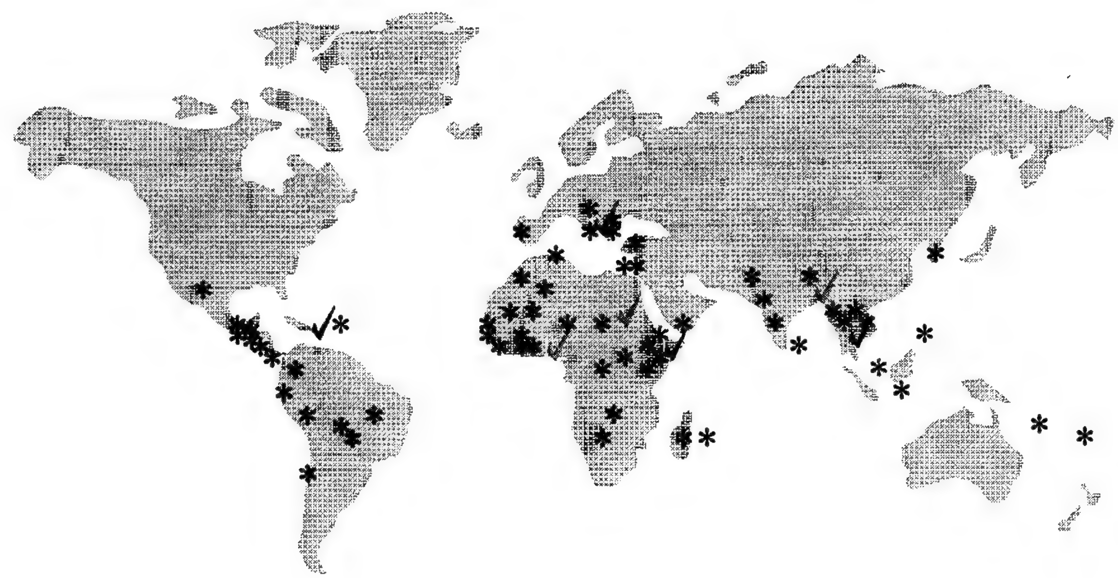
time and reduce the need to rely on crisis planning. Unfortunately, no two disasters are exactly alike. They vary in many ways including magnitude, duration, and location. Further, the populations that are affected by disasters also vary greatly as well as their self-recovery ability. For example, a country that has a sound government and infrastructure is less likely to require outside aid than a third world country whose government has collapsed. In addition, the condition of the recipients will also vary the material requirements. The existence of unpredictable variables that will require special handling by the logistician is commonplace in executing humanitarian operations. The object of this thesis is to develop a model that is capable of accommodating much of the variability present in these operations to ensure adequate material response. In addition, the variables selected can be categorized for general use during the planning phase of an operation. The five factors are location, demographics of the population concerned, condition of the recipients, remaining infrastructure, and duration of the operation.

1. Location

Researching the various locations of potential disasters gives a great deal of insight into the logistical concerns that may arise. Geographical location and its associated climate have the potential to greatly influence the material requirements of a relief operation. For example, hotter climates require water due to the effects of evaporation while the same climate requires less food and clothing than cold climates. Further, the requirements for medical supply are affected by the types of diseases that are prevalent in a particular region or climate.

After reviewing the 67 locations that have received U.S. Government Disaster Assistance (from either man-made or natural disasters) five times or more in the last twenty nine years, which are found in Appendix A, nearly 60% of the countries also fall within two geographical patterns. One runs along the Mediterranean basin to the Middle East, Afghanistan, Pakistan, India, Bangladesh down to Indonesia and then North through the Far East, the other runs along the Andes through the Caribbean into the United States. [Ref. 17: p. 5] Of the remaining 40% of the countries, over 28% are in Africa or in close

proximity to Africa, like Madagascar. Oddly enough, out of 67 countries that have repeatedly called on the U.S. for assistance, only six are currently being reviewed by the Services as probable areas for executing humanitarian, evacuation, or peacekeeping operations in the future. [Ref. 20: p. 2-18] The areas currently being considered include Haiti, Nigeria, Sudan, Somalia, Bosnia, and Bangladesh. A seventh region, Cambodia, which has not required extensive assistance in the past is also being considered. Figure 2.1 is a visual display of the anticipated and past operational areas. The checks indicate the areas currently being reviewed by the services while the asterisks indicate the areas that have repeatedly relied on military intervention to recover from a disaster.



✓ Country currently being reviewed * Country has repeated relied on military intervention

Figure 2.1. Countries Continually Requiring Military Intervention *After: Ref. 20: p.2-19*

Haiti is a nation with a great deal of political instability. The country's government is continually in danger of a complete breakdown and its people are some of the poorest in this hemisphere. On at least three occasions in the last decade, this sad combination has resulted in large numbers of Haitians fleeing their homeland seeking refuge in United

States. Further, Haiti is located in an area frequented by natural disasters. Given the instability of the Haitian government, it is generally accepted that the nation would be unable to recover from a disaster independent of foreign assistance.

Nigeria's scenario involves evacuation and aid operations as a result of a breakdown in civil order. It is anticipated that this scenario will be very brief yet difficult to execute due to lack of civil order. Similarly, the Sudan scenario involves evacuation and aid. However, this scenario is modeled not because of the possibility of civil disorder but because of the increasing amount of terrorism connected with the country and its radical Islamic groups. Somalia, on the other hand, is considered because the internal civil war between rival warlords has left the country in shambles. As history points out, the aftermath of war leaves many people wanting or needing the essentials. Without a functioning government to assist the citizens' recovery, it is accepted that Somalia would require outside assistance to become a functioning nation again. Bosnia is also considered because of the potential damage that can be caused by the various warring factions. Somalia and Bosnia are both expected to be extended operations as it can take many years for a nation to recover from any type of national war. Finally, Bangladesh is considered because it is a nation that has been plagued with natural disasters and civil strife. Damage from natural disasters in this area tends to be severe due to the low terrain, the population density, shoddy housing, substandard or non-existent roads, and limited communications. In the past thirty years, Bangladesh has received U.S. aid at least fourteen times and the country continues to rely on outside assistance for disaster recovery.

Unfortunately, the literature points out that disasters do not discriminate and that they strike all around the globe. Although several of the locations previously discussed should be considered "hot spots," there are many other locations that should not be eliminated. Again. Appendix A justifies this claim. To incorporate the logistical needs of all various locations that may require humanitarian assistance, this model breaks down location based on the temperature or climate of the area. There are five climates that will be considered: desert, tropical, temperate, cold, and arctic. A desert climate is found in an

area where temperatures exceed 80 degrees and where little humidity is experienced. Typically desert climates experience extremely high temperatures during the day and very cool temperatures during the night. Many desert areas also have radical temperature changes in the winter months that need to be considered when determining material requirements. A tropical climate is found in a region where temperatures are in excess of 80 degrees Fahrenheit and high humidity levels are experienced (usually more than forty percent). There is little temperature variation in a tropical region which greatly simplifies the planning process. Temperate areas experience temperatures between 32 and 80 degrees Fahrenheit. In most cases, the temperature variations of a temperate area are in response to seasonal changes. A cold climate is one that has temperatures ranging between 0 and 32 degrees Fahrenheit. Cold climates are experienced when seasonal changes occur in desert, temperate, and arctic climates. Finally, an arctic climate is one that has temperatures below 0 degrees Fahrenheit. Although there are very few recorded operations in arctic regions, the climate is considered to provide additional robustness to the model.

2. Population Demographics

Population demographics refer to the statistical make-up of the recipients. That is, how many men, women, and children of what ages require assistance. Military logistics planning factors are based on a predominately male population between the ages of 18 and 35. It is obvious that these planning factors fail to encompass the needs of a population comprised of both sexes between the ages of 0 and 99.

This variable is included to address the different needs of men, women, and children. If the logistician were to order supplies for a mixed population based solely on the needs of adult males, many shortfalls and excesses would be experienced. For instance, men traditionally require substantially more calories than women or children. When all the food items are purchased the operation will experience a great deal of waste as most women and children can not possibly consume the calories required by a male. Moreover, the actual make-up of an adult male's diet fails to address the higher quantities

of milk required by children which will result in shortfalls. To accommodate for the variation in needs, this model is broken down into four basic categories: children below three years of age, children between the ages of three and twelve, females above twelve years of age, and males above twelve years of age. In addition, another category will be included when considering medical requirements. The additional category is adults over the age of 65. Once the planner determines what sexes and ages are involved in a disaster he can then select the appropriate mixes. The model provides for mix combinations in five percent increments. For example, a disaster could result in a victim population consisting of 5% children below the age of three, 20% children between the ages of three and twelve, 35% females above the age of twelve, and 40% males above the age of twelve.

3. Physical Condition of the Recipients

The physical condition of the recipients comes into play when determining subsistence and medical requirements. A population that is ailing before a crisis will need more medical care than a population without prior ailments. Furthermore, many Third World nations are severely malnourished and require special diets to recover. To include these unique variations in this model, two general categories of physical condition are included. The first category is the physical condition of the recipients before the disaster. This refers primary to the recipients nutritional status. This model will use three broad classifications for nutritional status: nourished, undernourished, and malnourished. Because of the variations in cultures around the globe, there is no definitive measure established to determine the nutritional status of a population. Furthermore, there is a great deal of overlapping between the categories which makes the classification of the population difficult.

For this model, the categories will be oversimplified to establish unambiguous separations. A nourished population is a population that has adequate amounts of food and calories. Since adequate varies from culture to culture, the key identifying feature of this category is that the population as a whole was not lacking food or nutrients. Examples of nourished populations include the United States, Great Britain, and France.

Undernourished and malnourished populations, on the other hand, lack adequate amounts of food and calories. Bangladesh is an example of a undernourished country while Ethiopia is historically classified as a malnourished country.

To make the distinction between undernourished and malnourished, anatomical changes will be considered. An undernourished population will lack a sufficient diet yet the damage caused by insufficient nutrients has not yet manifested into any outward anatomical changes. In layman's terms, the population is hungry. If a population remains undernourished for long periods of time, it will slowly transition to the malnourished category. Malnutrition is essentially bad nutrition. Unfortunately, this definition can be misleading because an undernourished population also has bad nutrition. The technical definition of malnutrition is a condition in which there is an impairment of health, growth or physiologic functioning resulting from the failure of a person to obtain all the essential nutrients in proper quantity or balance. [Ref. 21: p. 6-7] In other words, a malnourished population has noticeable outward signs of poor nourishment. The children are normally the first to display the outward effects of malnutrition with ailments like Protein-Calorie Malnutrition. Some of the manifestations of malnutrition include growth inhibition, poor wound healing capabilities, tissue breakdown, abnormal metabolic processes, and ultimately death. [Ref. 21: p. 17] It is also important to note that most areas where malnutrition is prevalent are very poor. In addition, these areas also experience a high number of parasite type diseases and high infection rates which are a consideration when determining medical requirements.

The second category of physical condition is determined by the extent of damage the victims receive from the disaster. This refers to the type, severity, and number of injuries obtained. The model will include the following breakdown: injured, homeless, and those in need of assistance. The advance party can contact local medical facilities and government agencies to estimate the numbers for each category. The classifications are self-explanatory, but to ensure proper classification each category will be explored briefly. The term injured refers to the number of people who require medical attention. Homeless

refers to the number of people that have been left without adequate shelter. Finally, individuals in need of assistance are those people that require food and clothing. In most cases, individuals that are classified as homeless also require food and clothing. The model allows the planner to classify the number of people in the various categories by estimating the percentage of the population that fall into each category much like the system used to determine the population's demographics.

4. Remaining Infrastructure

The remaining infrastructure is particularly important when considering construction materials, equipment, fuel, water requirements, and how material will be distributed for an operation. Infrastructure refers to housing, hospitals, roads, utilities, etc. Generally speaking, a community's infrastructure is all the property that binds a group of people or families into a town or a city. A sound infrastructure can reduce the planner's work. For example, the existence of adequate community structures to house the homeless significantly reduces the material and manpower requirements of an operation. Construction materials to build temporary housing and the personnel to build the housing will not be required. Furthermore, operating hospitals reduce the need for rapid shipment of medical supplies and a good highway and street system makes delivery of time critical items much more efficient. Unfortunately, many of the countries that continually lean on the United States for disaster assistance, like Bangladesh, have weak to non-existent infrastructures. Weak infrastructures increase the demands on the planners and operational staff.

To include this variable in the model, infrastructure is broken into three categories. The categories are functional, damaged, or non-existent. If the remaining infrastructure after a disaster is at least 80% functional, it is classified as functional. For instance, if the public utilities are or can be made functional quickly, there is minimal damage to public buildings that are capable of housing the homeless and protecting the injured, and the road system does not handicap the relief effort, the infrastructure can be classified functional. A functional infrastructure is most likely to be found in a developed country that has

experienced a disaster. The 1989 earthquake in San Francisco did a great deal of damage to the community, yet there was still a functional infrastructure remaining to house the homeless, conduct rescue operations, and care for the wounded. Unfortunately, this may not always be the case. For example, if a nuclear bomb was dropped on San Francisco, it is doubtful that infrastructure would be classified as functional after the blast. An infrastructure is classified as damaged if significant repairs or supplements are required for the area to become self-sufficient. A recent example of a weak infrastructure is the infrastructure that was available to support Operation Sea Signal in Guantanamo Bay, Cuba. Although Guantanamo is a fully functional naval base, it was not prepared for supporting 30,000 additional personnel. The base lacked housing, water, and supporting personnel. All three areas had to be supplemented before a functional infrastructure emerged. Finally, an infrastructure is classified non-existent if very little to no identifiable infrastructure exists or remains. In November 1970, Bangladesh (then East Pakistan) was struck by a cyclone which was immediately followed by the worst tidal wave in recent history. The result of this compounded disaster was complete destruction of the country's infrastructure, the majority of the livestock, and water system. It took over two years for the country's infrastructure to be rebuilt. Without the outside aid that was afforded to the country, it is doubtful that the infrastructure could have been rebuilt.

5. Duration of the Operation

The duration of the operation is extremely important to logistics planners because it allows planners the opportunity to determine whether a replenishment cycle needs to be established or whether a one time issuance of aid will suffice. For this model an operation's duration will be classified into one of following categories: brief, temporary, extended, and indefinite. To be considered a brief operation, the mission can not exceed one month. Brief operations normally do not require resupply. Examples of brief operations include the disaster relief operations conducted in Mauritius following Cyclone Cervaise in February 1975 and the four day journey of FFG-24 *Jack Williams* to deliver medical supplies to Antigua in 1990. An operation is considered temporary if it lasts more

than a month but less than six months. These operations require replenishment cycles. The assistance provided by LPD-10 *Juneau* and LSD-43 *Fort McHenry* during the clean-up effort of the *Exxon Valdez's* oil spill in 1989 and Operation Sea Angel, which provided humanitarian assistance to people of Bangladesh after Cyclone Marian in 1991, are examples of temporary operations. Operations that run between six months and a year are classified as extended. Along with replenishment cycles, these operations may also require planning to replace worn items. Operation Sea Signal which supports the Haitian and Cuban refugees in Guantanamo Bay, Cuba is currently an extended duration operation. Indefinite refers to operations where no termination of military assistance is anticipated for more than a year. Examples of indefinite operations include Operation Provide Comfort which is assisting the Kurdish refugees in Iraq and the sporadic rescues of thousands of Vietnamese refugees in the South China Sea which began in May of 1979 and continued through 1980. [Ref. 22]

Until recently, very few military humanitarian operations have exceeded six months in duration. Actually, the overwhelming majority (more than 80%) of documented operations are concluded in less than a month. The literature review of these contingencies suggests that operations with longer durations are confined to operations involving refugees and famine victims. Although these distinctions are notable, they do not eliminate the need to provide additional flexibility in the model by including all the above categories.

6. Additional Considerations

Although many variables will affect the specific items that should be purchased to support humanitarian operations, very few additional variables affect the actual quantities required. For example, a population's cultural and religious background will certainly affect what is ordered but these variations will have little effect on the actual requirement. Perhaps a population will not eat any pork. The people still require the specified quantities of food, just no pork. It is easy to see how the variables that affect specific ordering requirements can be confused with variables that affect material requirements.

For this model, the main concern is not the specific requirements so cultural norms and other variables that do not directly affect quantities required will not be included. Furthermore, since this model is intended to encompass the spectrum of humanitarian operations it would be very difficult to assess and quantify the degree of cultural variation experienced from country to country much less village to village. However, once the required quantities are determined, the logistician must the research the cultural norms of the recipient population to determine what items to order.

E. CHAPTER SUMMARY

Figures 2.2 and 2.3 have been created to summarize the chapter. The figures use the model structure developed in this chapter and a flowchart type methodology to classify a variety of modern humanitarian operations. Figure 2.2 addresses natural disaster while Figure 2.3 addresses man-made disasters. In addition, when the data is available, the figure will identify the appropriate variables for each of the humanitarian operations. The figures are not intended to address every humanitarian operation ever conducted by the military. However, they are designed to provide the reader with an understanding of how the model can be applied to past and future operations.

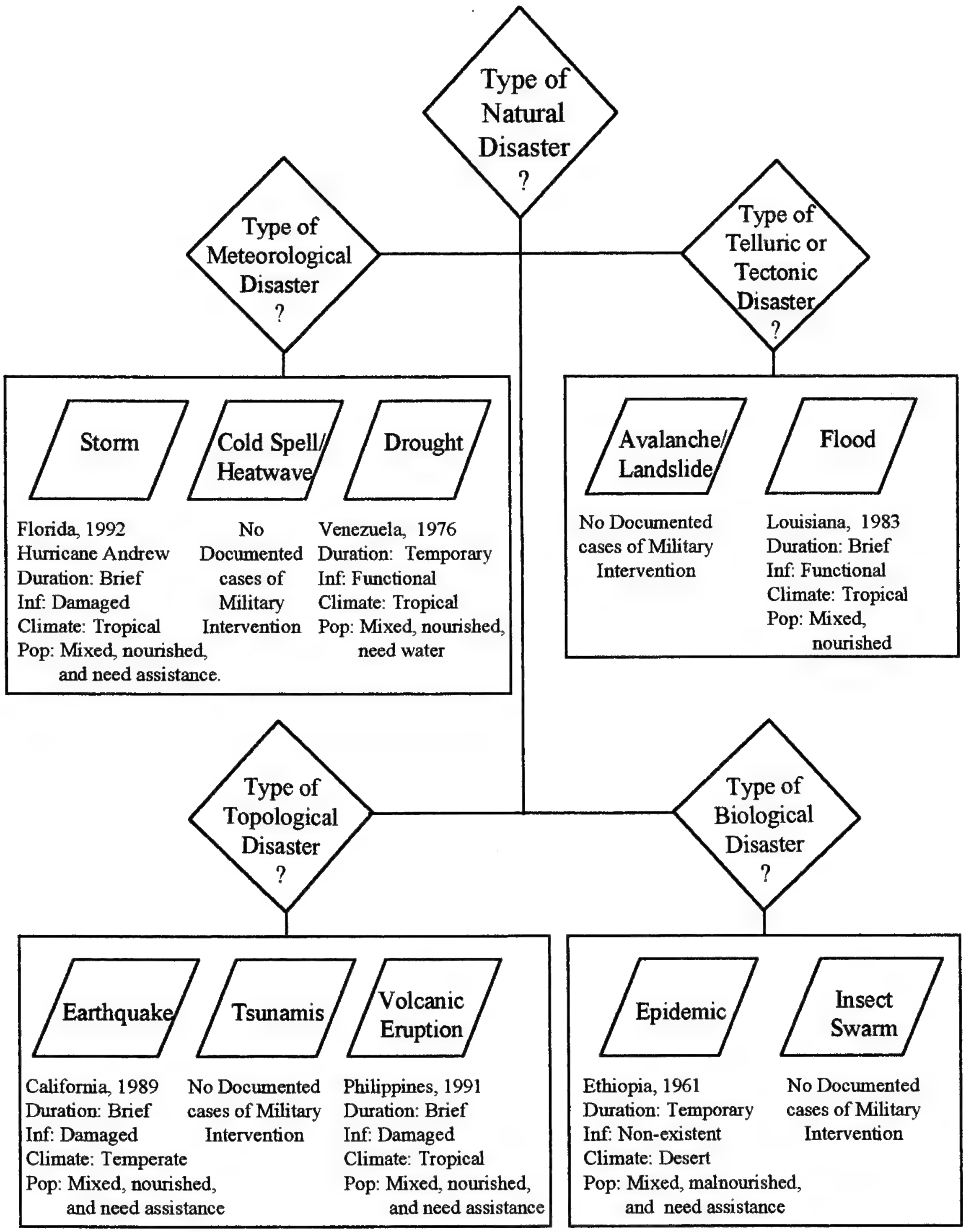


Figure 2.2. Examples of Classifications Using the Model Developed for Natural Disasters

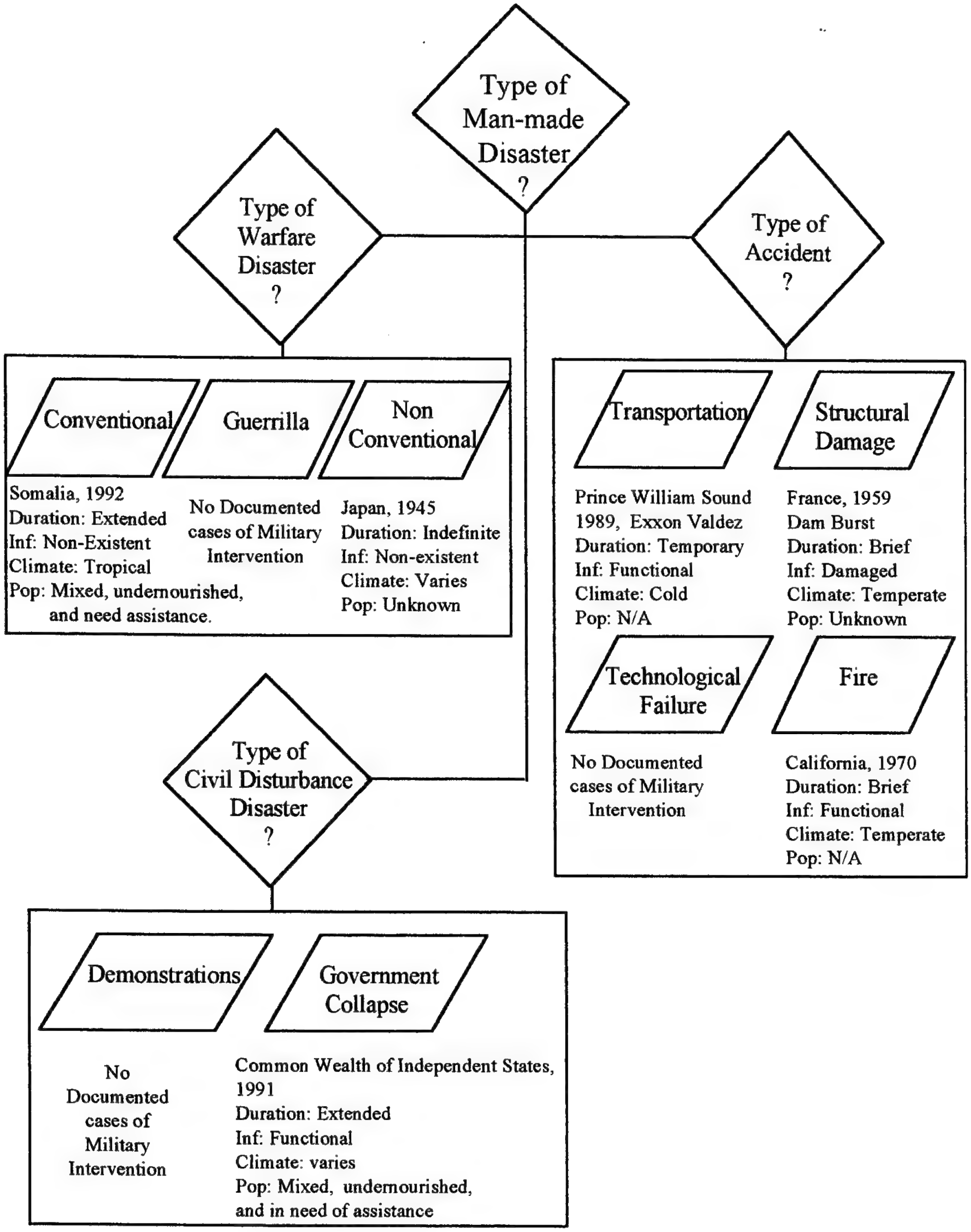


Figure 2.3. Examples of Classifications Using the Model Developed for Man-made Disasters

III. PLANNING FACTORS

A. BACKGROUND

> It is unfortunate, though often not realized, that people seldom estimate random events correctly; they always tend to remember the "exciting one" and forget the others, and as a result their opinions are nearly always unconsciously biased...Military personnel (and indeed most people without rigorous scientific training) tend to take opposite opinion of the relative validity of opinion versus facts...If science has learned one thing in the past three centuries, it is that such a point of view must be avoided if valid scientific results are to be achieved. [Ref. 23: p.5]

According to Joint Publication 1-02, a planning factor is a properly selected multiplier used in planning to estimate the amount and type of effort involved in a contemplated operation. For those whose knowledge of logistics is limited, this definition uses terminology, like multiplier and effort, that may be ambiguous. A more descriptive definition of a planning factor is given in *Logistics in the National Defense*, FMFRP 12-14. The field manual's definition is a numerical representative of the qualitative relationship between the composition and employment of military forces and the availability, consumption, or utilization of materials, personnel, facilities, and services. However, this definition fails to make the distinction that planning factors are estimates.

The definition used for this thesis combines the best elements of the previous two definitions:

> *a numerical multiplier used in planning to estimate the qualitative relationship between the population being supported and consumption or utilization of materials, personnel, facilities, and services.*

As such, they are based on experience or usage data. They are a predictive planning tool. For the logistics planning factors to be good planning tools, the planners should know the circumstances under which the fundamental usage data was collected and how the factors were derived. Unfortunately, usage data and documentation for the spectrum of

humanitarian operations is very scarce, so alternative methods of developing the planning factors need to be considered. Since humanitarian operations are documented sufficiently by international relief organizations (e.g., the United Nations, Red Cross, World Food Program, etc.), one option is to review the operations conducted by the various organizations to derive planning factors based on these operations and argumentative reasoning.

The goal of logistic planning factors is two-fold. The factors must aid the determination of quantity and mix of material to support budgeting and buying decisions while, at the same time, they should aid in the determination of material and transportation requirements for contingency support. [Ref. 24: p. 21] To successfully aid planners, a planning factor should be flexible, scenario-driven, and realistic. Furthermore, since the planners rotate regularly, planning factors should be simple to minimize turn-over time.

Good logistic planning factors can be beneficial to logisticians and Commanders. First, planning factors allow a large number of situations to be readily evaluated. They give a Commander a feel for the quantity of supplies he needs to support the various missions that he is considering. In other words, the factors offer contingency planning capabilities. Second, planning factors help the logisticians determine the broad aggregate of supplies required while identifying mission critical items. For instance, a logistician may be tasked to support 3000 people who require 2.2 pounds of food per person with kitchen facilities that can only prepare 4500 pounds of food a day per day. Some quick arithmetic points out that the kitchen facilities are unable to support the 6600 pound per day requirement and provides the logistician an opportunity to evaluate the alternatives before the problem becomes a crisis. In short, logistics planning factors speed up and simplify the initial push planning process.

Unfortunately, planning factors are not without their faults. An alarming number of reports indicate that many senior officers and logisticians do not trust the accuracy of logistic planning factors. [Ref. 24: p. 4] The main reason for this distrust is lack of documentation regarding the origins of the existing planning factors. The uncertainty

surrounding the factors causes planners to speculate whether the numbers are valid for "their mission." As a result, planners have the tendency to alter the numbers to levels they believe fit the situation at hand. When logistical errors like under- and overestimations are experienced, regardless of the cause, the planner distrust is heightened. Finally, many leaders believe that some things are not quantifiable and that a single number can not possibly cover the myriad of operations that the military executes. However, logistics planning factors continue to be formally used in all military planning.

B. CLASSES OF SUPPLY

Although not traditionally used by the Navy, the commodities discussed in this thesis are classified according to the classes and subclasses of supply prevalent in the Army and the Marine Corps. A summary of the traditional classes of supply and their associated planning factors is found in Table 3.1. [Ref. 18: p. 6-51] Using the classes of supply provides a standardized approach to classifying the materials required for these operations that is insightful and adheres to the Federal Supply System (FSS).

Class	Description	Representative Planning Factor
I	Subsistence	Pounds/per person/per day
II	Individual Equipment	Combat active replacement factor (CARF)
III	Petroleum, Oils, and Lubricants (POL)	Gallons/per item/per day
IV	Barrier and Construction Materials	CARF/bill of material
V	Ammunition	Rounds/per weapon/per day
VI	Personal Demand Items	Pounds/per person/per day
VII	Major End Items	CARF
VIII	Medical Materials	Casualty rate/per day
IX	Repair Parts	Mean time between failure rate
X	Material for Nonmilitary Programs	none established

Table 3.1. Traditional Classes of Supply and their Associated Planning Factors

A quick examination of the representative planning factors currently used illustrates that they are not ideal for humanitarian operations. For humanitarian operations, the primary concerns are food, shelter, medical care and clothing. With this in mind, the Classes I, II, IV, and VIII will be main focus of the thesis. However, if these were the only classes of supply that were considered, the model would lack the flexibility to address the special needs of humanitarian operations with unique circumstances or longer durations. For instance, while the Joint Task Force in Guantanamo Bay, Cuba was establishing the emigrant camps, they came across a problem with the terrain. Because of the lack of level surfaces, the JTF was forced to clear the land before they could begin setting up the emigrants' camps. Clearing land requires large equipment that needs fuel and repair parts. Therefore, there is a need for Class III, Class VII and Class IX supplies to be considered. Even civilian operations like the bombing in Kansas City have seen the need for large equipment to continue the rescue effort. For operations that extend beyond a few days, the logisticians may want to consider Class VI items like shampoo, soap, and toothbrushes. Furthermore, operations that are considered extended or indefinite may consider purchasing quality of life items for the victims. These items can be school books, art supplies, or just baseballs. Regardless of the item, they are all considered Class X supplies for this model since they have no appropriate military classification.

As the previous discussion indicates, almost every class of supply is befitting to the planning process for humanitarian operation. However, two classes of supply are omitted from this study, Class V and Class IX. The primary reason for omitting Class V is lack of documentation to formulate logical factors. Since most humanitarian operations, civilian and military, involve rendering assistance to individuals that are in dire straits, guns and ammunition are rarely an issue. In addition, much of the literature on these operations recognizes that civilian organizations are not trained nor tasked to carry arms. The exception is humanitarian operations that are conducted in conjunction with peace-keeping operations. In the case of dual mission operations, like Somalia, the current planning factors for ammunition were used. Fortunately, these planning factors appear to be

sufficient since even small scale combat is considered combat and the models currently available to simulate combat can assess these needs. It should be stressed that although Class V supplies are not considered by this model, their relevance should not be understated. Whenever large numbers of people are "detained" for an extended period of time there is a tendency for internal uprisings. The uprising by the Cuban emigrants in Panama is a very good example of the problems that can occur when peoples' lives remain in limbo for extended periods of time. At the very least, the logisticians should consider shipping standard riot gear to any operations exceeding thirty days. Regarding Class IX supplies, repair parts are normally demand supported with the assumption that all critical items will be airlifted. Since the literature review appears to back this assumption, the current planning factors will suffice.

Table 3.2 summarizes the classes of supply that are included in the model. It should be noted that some of the classes' descriptive names have been changed to better suit the needs of humanitarian operations. Also, the table contains a brief overview of the items that are included in each class of supply.

Class	Humanitarian Title	Includes
I	Subsistence	Food, water, and serving items
II	Personal Supplies	Clothing, shoes, personal equipment (tents, cots, sheets, and misc. furniture) and housekeeping equipment and supplies
III	POL	All fuel (solid, liquid, and gas), lubricants, and chemical products
IV	Construction Materials	All fortification, barrier, and infrastructure (hospitals, kitchens, etc.) materials
VI	Hygiene Items	Soap, shampoo, toothpaste, etc.
VII	Support Equipment	Waste Disposal Vehicles, trucks, buses, forklifts, etc.
VIII	Medical Supplies	Medical emergency supplies, vaccines, blood, general clinic supplies, etc.
X	Humanitarian Specific Items	Quality of life items

Table 3.2. Classes of Supply Included in the Model

C. DERIVATION

In this section, the assumptions made to develop the planning factors are described as well as the derivation of each planning factor. For some classes of supply, a discussion regarding the methodology employed is provided. A summary of all the derived logistics planning factors can be found in Appendix H.

1. Assumptions

- The military is the sole provider of aid.

This assumption is made because whether an outside agency will decide to participate or whether the host nation will be able (or willing) to participate can not be readily determined. Furthermore, the degree of assistance provided by the Host Nation and other agencies varies greatly from operation to operation. With this assumption, the planning factors will have more flexibility. Since the factors are aggregated requirements, it is much easier to reduce the quantity required by the amount that an outside agency provides than it is to guess how much should be ordered to compensate when an agency fails to participate.

- The operations are not intended to be permanent in nature.

Although several past humanitarian operations appear to have slighted this assumption, it is generally accepted that the military's involvement in these operations should be kept to a minimum. [Ref. 1: p. 34] Furthermore, case studies show that the overwhelming majority of humanitarian operations that the military participates in are short in duration. [Ref. 22] The military generally sets up initial communications and maintains the operation through the relief stage. When the initial emergency is over, the mission is turned over to the Host Nation or an international relief organization who will maintain the operation for the duration.

2. Development of the Planning Factors

Classes I, II, III, IV, VI, and X are historically characterized by fixed planning factors that are derived from a simple consumption methodology that is based primary on

policy. [Ref. 25: p. 11] All the planning factors derived for this model will make use of this methodology. The advantage of this method is its simplicity. Although, the methodology is easy to use and understand, it lacks supporting documentation like historical and operational data. Therefore, the derivation of the planning factors should be thoroughly understood by the planners so that the factors can be properly employed. In addition, the planners need to understand how the variables are incorporated into the derivation so that they do not compensate for variation already considered by the model. In the following sections, the planning factors for each class of supply will be derived and a discussion regarding the incorporation of the variables that affect the class of supply will be conducted.

a. Class I - Subsistence

For this model, subsistence is broken into three parts and each part is derived separately. The parts are food, water, and eating utensils. There are two reasons for separating this class of supply into three parts. First, the units of measure differ. Food and utensils are measured in pounds per person per day while water is measured in gallons per person per day. Second, the planner may not be required to supply food, water, and utensils. The breakdown allows the planner to assess the needs based on the mission requirements rather than providing the planners a single figure that exceeds the actual requirements.

The first step in determining a planning factor for food is to establish the nutritional requirements for a population. The most conspicuous requirement is that of energy for the body to work. The human body gets its energy from food and the traditional unit of measure for the energy value of food is a Calorie. Therefore, the following analysis will be conducted to determine the daily caloric requirements of an individual rather than the number of pounds required by an individual. The problem of converting calories to pounds will be taken up later.

Scientists use the basal metabolic rate (BMR) as the starting point to determine how many calories an individual's body needs to maintain vital functions when

nothing is being done. BMR designates the energy metabolized by the body when in complete rest. Due to the number of items that affect a person's BMR like sex, age, weight, body composition, and activity level, it is difficult to develop a standard that is able to accommodate the needs and habits of everyone. However, researchers have developed dietary standards for various activity levels, ages, sexes, and weights using the BMR as a baseline. [Ref. 26: pp. 187-196] The results have been presented in many ways. The most recognized way to present dietary requirements is the Recommended Dietary Allowances (RDA) table which presents the prescribed level of nutrition that will maintain good health for a large percentage of a population. The RDAs are not "requirements;" however, they are based on the idea that an individual consuming a diet that provides the recommended amounts of all nutrients would be unlikely to suffer nutritional inadequacy. To accomplish this, the scientists assume a normal distribution of individual requirements and set the standards two standard deviations above the average requirement. [Ref. 21: p. 68-73] Unfortunately, the RDA's do not make the direct calculation of the caloric requirements for an undernourished or malnourished population very easy. However, a second more flexible way to determine caloric requirements is available which identifies the calories required per pound of body weight.

To determine which method is appropriate for the situation at hand, an assessment of the population's nutritional status is helpful. There are many ways to assess the nutritional status of a population but, with the time constraints imposed on these operations, a quick height/weight comparison is by far the easiest and most common method. Furthermore, the only equipment that is required to make the assessment is an accurate hospital scale. The notion is that the advance party would take height/weight samples from the recipient population and compare the sample values to the standard height/weight tables found in Appendix B. The comparison would involve calculating a

percentage of the table's standard values, P, by dividing the observed weight of the person, W_o, by the standard weight from the chart, W_s, associated with the sampled person's height. The resulting formula is

$$P = W_o / W_s. \qquad (3.1)$$

The interpretation of the calculated percentage is describe in Table 3.3. [Ref. 21: pp. 84-85]

Percentage	Interpretation
<80%	Malnourished
80-90%	Undernourished
90-110%	Nourished
110-120%	Overnourished
>120%	Obese

Table 3.3. Interpretation of Calculated Height/Weight Percentages

If the calculated percentage is 90% or greater, the RDA tables found in Appendix C can be used to determine caloric requirements. This is acceptable because, if an individual falls into the overnourished or obese category, there is strong evidence indicating that the individuals current intake is well above what their bodies require to function properly. A reduction in these individuals' caloric intake should not adversely affect their health but, it may reduce their body mass. Again, this is not a steadfast rule because body-builders tend to fall into the overnourished category and yet they require higher caloric intakes than those established by the RDA. However, body-builders do not account for large percentage of the population so the rule will apply in most cases.

There are two ways to estimate the caloric requirements of an undernourished population. First, part of the RDA, equivalent to the percentage previously calculated, can be used. In other words, the percentage already calculated, P, will be multiplied by the caloric requirement given in the RDA. The result will be a reduced caloric requirement that can be increased slowly as the populations nutritional

status improves. The second method involves determining the average weight of each demographic group found in the population and then using the required calories per pound of body weight chart located in Appendix D. To use the chart, the demographic group in question is located in the chart and the multiplier for that group is extracted and multiplied by the estimated average weight for the group that has already been calculated. The multipliers from Appendix D can also be used if the RDA charts are unavailable or if the recipient population's heights exceed or fail to meet the minimums listed in the standard height/weight charts.

If the recipient population is assessed as malnourished, medical personnel need to be consulted before establishing caloric requirements. As stated earlier in the text, these individuals may require special or medically supervised diets. However, in cases of minor malnutrition, the medical expects may advise a low calorie, bland diet. The calories for the low calorie diet can be determined using the same method described previously for undernourished populations. Regardless of the initial diet given to an undernourished or malnourished population, the recipient population requires constant monitoring because as time passes their caloric requirements and in many cases their entire diet can be expected to change. The logisticians need to keep a close eye on the nutritional requirements to avoid supply shortages that may occur as a population's caloric intake changes.

When assessing the nutritional status of adolescents there is more variation in what is considered normal due to the varying growth rates. In many cases, an adolescent will "outgrow" the chart designed for his age group and the logistician is forced to assess the child as a adult. As a general rule, when assessing the nutritional status of children, Table 3.4 should be used. All other calculations remain the same. The difference between Table 3.3 and Table 3.4 is the category considered normal, or nourished, is larger to accommodate a child's growth spurts. It is interesting to note that the minimums are not altered. This is because there is a minimum weight established for each height regardless of age.

Percentage	Interpretation
<80%	Malnourished
80-90%	Undernourished
90-120%	Nourished
120-130%	Overnourished
>130%	Obese

Table 3.4. Interpretation of Calculated Height/Weight Percentages for Adolescents

Unfortunately, there will be cases when even a simple height/weight comparison is too time consuming. If this should be the case, the logistician can use reference manuals or information obtained from the Host Nation to estimate the nutritional status of the recipient population. One reference text that provides a great deal of information to the planner with minimal effort is a computerized version of the World Atlas. [Ref. 27] The software not only gives the planner information on the geography of the region but also gives many statistics on the region's population including the caloric consumption. Although the figures in reference manuals are population averages, they can be used as a baseline until further validation is available. Once the operation begins, the logisticians, with the assistance of the medical staff, can quickly make an assessment of the nutritional status of the population and compensate appropriately. The assessment can be accomplished using the height/weight comparison already discussed or any other medically approved technique (e. g. skin fold caliper test, blood testing, etc.).

Now that the caloric requirements for the population have been determined, the problem of converting calories into a usable logistics planning factor remains. Starting with the RDA table that they have developed, scientists have been able to develop a food plan that effectively transforms the chemical factors surrounding nutrition into articles of food that one actually chooses and consumes. [Ref. 26: p.516-517] The food plan divides the calories into broad categories of everyday foods with the same goal as before, dietary adequacy. The divisions are much like servings; however,

they are expressed in the scientific equivalent, pounds. The result, which is reproduced in Appendix E, is a table that converts calories into pounds.

The final problem is to determine the relationship between calories and pounds. First, regardless of the caloric requirements of an individual, the nutritional goals remain the same. That is, whether an individual intakes 1500 calories or 3000 calories, the calories consumed should still comprise a maximum of 30% fat, 12% protein, and 58% carbohydrates. [Ref. 28: p. 10] Therefore, as caloric requirements increase the quantity of food required increases proportionately but the specific food items are still distributed as they were at the lower caloric requirement. With this in mind, a linear relationship between calories and pounds of food per person was explored.

Using the calories and pounds found in the Family Food Plan (Appendix E), a linear regression model was established with pound per person per day, *PP,* as a function of calories per day, *C*. Thus,

$$PP = a + bC + e \qquad (3.2)$$

where a and b, are unknown parameters in the model and where e is the error term. The error terms, e, are assumed to be Normal ($\mu = 0, \sigma^2$). Only fourteen of the seventeen categories were used because three of the categories, pregnancy, lactating, and children under the age of one, have special caloric requirements. For instance, children under the age of one get most of their calories from milk rather than a variety of foods. Finally, using the method of least squares, the model was fit and the fitted line is

$$PP = 1.384 + .00096C. \qquad (3.3)$$

The results of the analysis are summarized in Appendix F. Although this model fits quite well, attaining a R^2 value of .979, it assumes that all milk and milk products will be shipped in the liquid form. That is, liquid milk will be shipped to fulfill these requirements. This assumption is unlikely and uneconomical. The form of the milk products shipped depends on the availability of refrigeration space, the availability of fresh water, and the palates of the recipient population. Therefore, a second linear regression model was

considered that excludes the requirements for milk products. Again, using the method of least squares, the model was fit and the fitted line is

$$PP = .1811 + .00083C. \tag{3.4}$$

The results of this analysis are summarized in Appendix G. The model fit very well. This time the R^2 value that was attained was .995, indicating a very strong linear relationship between calories per person and pounds per person.

The final step was to verify the assumption that the errors are approximately Normal ($\mu = 0, \sigma^2$). Again, the results are summarized in Appendix G. The analysis estimated μ to be -2.47E-19 and the confidence interval successfully covered zero. Finally, all the goodness of fit tests attained p-values in excess of .15 which provides sufficient evidence to conclude that the errors can be adequately described by a normal random variable with $\mu = 0$ and a constant σ^2.

The next concern is to establish a logistics planning factor for water. There are two schools of thought regarding the establishment of a logistics planning factor for water consumption. The first method involves a gross requirement figure that combines all water needs into one requirement adjusting only for climate. While this method is certainly easy to understand and adjusts for climate (considered the primary factor in water consumption [Ref. 25: p. 13]), the methodology does not allow the planner to determine whether specific provisions, like medical requirements, have been included in the aggregated figure. Furthermore, this method does not allow the planners to assess the specific requirements for potable and nonpotable water. The second method still uses a gross requirement figure but, the figure is derived by breaking down the water requirements into smaller planning factors such as drinking water requirements, hygiene requirements, etc. Unfortunately, the factors the Services have developed by this method are extremely conservative. For instance, although there is a half a gallon a day provision for a sponge bath, the recommended consumption rate for hygiene water allows for only one shower a week; and, regardless of the climate, and the shower is only to consume seven gallons of water. [Ref. 29: p. 2-8] It is very unlikely that any European or North

American civilian community will take any shower that only consumes seven gallons of water. The Services themselves have conducted several studies to validate the current planning factors for water consumption. All the sources led to different conclusions, but they all allow for additional water for hygiene purposes. [Ref. 29: p.2-8; Ref. 30: p. D-2; Ref. 31: p. 4, Ref. 32: p. D-2] Therefore, some adjustments need to be made to these planning factors if they are to adequately reflect the requirements of a civilian population.

Because the second method appears to offer the most versatility, it will be the methodology used in this thesis. However, the breakdown will be slightly different from the breakdown traditionally used by the Services. The breakdown will be composed of six smaller planning factors. The breakdown includes drinking requirements, hygiene requirements, food preparations, laundry, medical treatment in the operating area (including heat treatment), and waste. There are additional water requirements for vehicle and aircraft maintenance, NBC decontamination, and grave registrations. However, the Services' planning factors thoroughly describe the requirements so they will not be discussed here.

Because water is essential to life, drinking requirements are considered a critical planning factor for most operations, especially humanitarian operations. The planning factors developed are based on the medical intake requirements displayed in Table 3.5. As Table 3.5 indicates, demographics play a key role in determining the water needs. Since these values are the average requirement, ten percent will be added to each category to account for individuals who consume more than average amount of water. In addition, these requirements vary greatly in different climates because temperature influences the amount of water the body loses. For instance, a person is not likely to perspire a great deal in an arctic environment; but, the water loss due to perspiration in a desert climate can be elevated as much as 100% from the losses experienced in an arctic environment. [Ref. 33: p. 2280] To accommodate the water requirement variations experienced in different operating areas, the climate factor will be used. Although, the actual water requirements for humanitarian operations differ from the Services'

requirements, the effects associated with climate remain the same. Therefore, the climate factors currently used by the United States Marine Corps will be used. The climate factors are summarized in Table 3.6. Using a climate factor is quite simple. First, the planner will determine the population's drinking water requirements based on Table 3.5. Then, the appropriate climate multiplier is extracted from the Table 3.6 and multiplied by the population's drinking water requirements.

	Water Needs	
Category	qt.	gal.
Infants	1.3	0.325
Males	2.9	0.725
Females	2.1	0.525
Pregnancy	2.4	0.6
Lactation	2.6	0.65

Table 3.5. Daily Intake Requirements for Water [Ref. 28: p. 2280]

Climate	Multiplicative Factor
Temperate	1.00
Tropical	1.33
Desert	1.60
Cold	0.80
Arctic	0.66

Table 3.6. Climate Factors for Water Consumption [Ref. 25: p. 13]

As stated previously, the Services' planning factor regarding water for hygiene purposes fails to address the requirements for a civilian population. To illustrate this, the reader is asked to estimate how much water he uses to complete his daily hygiene regime ... would 2.7 gallons of water be sufficient? How does one know when 2.7 gallons have been consumed? How does one limit water consumption while maintaining its availability? Even Task Force Commanders seeking high soldier morale have thrown out the overly conservative planning factors for more culturally accepted rates. [Ref. 34: p.15]

This is not say the population should be granted an unlimited water supply, just a more liberal rationing policy. With this in mind, the planning factor for hygiene will be derived using more realistic requirements, understanding that the only way to truly limit water consumption is to restrict its availability.

The first step in determining the amount of water needed to satisfy the hygiene requirements is to decide what is included in the personal hygiene and what variables affect the requirements. For this model, hygiene requirements include water for shaving, washing hands, brushing teeth and showering while the primary factor affecting the requirements is the operating area. From a medical standpoint, at the very least, a population needs to maintain dental hygiene. The military uses a planning factor of 1.7 gallons per person per day for shaving, dental hygiene, sponge baths, and hand washing. [Ref. 29: p. 2-8] Again, this is difficult to enforce but it is certainly not unreasonable and can adequately address dental hygiene. Therefore, this value will be the minimum personel hygiene planning factor for males. For females and children, .7 gallons (the amount allotted for shaving) will be subtracted from the 1.7 gallons per male per day requirement, resulting in a 1 gallon per female (or child) per day hygiene requirement. The final hygiene requirement is the water required for bathing. Unfortunately, determining bathing or showering requirements is one area where cultural norms could affect the quantities required. Although it is true that frequent showering is not medically necessary and can be considered a luxury, most cultures accept daily bathing as a norm. The degree to which this norm is applied has a great deal to do with the literacy rate of the victim population. However, as a minimum, the Office of the Surgeon General has recommended from a health maintenance standpoint one shower per week. [Ref. 32: p. D-2] Therefore, for limited periods of time, the Services' planning factor of one shower per person per week will serve as the minimum bathing requirement. If the infrastructure exists or as it develops, more liberal limits should be established to accommodate the population's hygiene norms.

To determine the quantity of water required for a shower, an extensive literature search was conducted. It was found that normal commercial shower heads deliver approximately 5 gallons per minute while commercial, restricted flow shower heads deliver approximately 3 gallons per minute. Even using the restricted flow values, the current hygiene planning factor of 7 gallons per person per week only provides one, 2 minute and 20 second shower once a week. Unfortunately, most civilians do not time their showers; and, if they did, 2 minutes, 20 seconds is not a common time increment. So, the goal was to find a showering time with a more common increment that can easily absorb excess use by small portions of the population without limiting the availability of water.

Interesting enough, the Army Field Manuals (FM 10-280) state that each soldier is permitted a seven minute shower. Even using the shower head flow values derived by the Army of 2.2 gallons per minute, the 7 gallons per person per week is not sufficient to address the seven minute shower. [Ref. 32: p. D-2] In fact, the Services would require 15.4 gallons per person per shower to satisfactorily address their requirements using their flow rates or 21 gallons per person per shower using commercial shower heads. The literature search showed that 17.5 gallons per person per shower has been successfully used by the Services for longer duration operations. [Ref. 31: p. 15] This planning factor combined with commercial restricted flow shower heads provides the population with over five minutes of shower time while combined with the military shower head this factor provides over seven minutes of shower time. Furthermore, using the five minute time increment with the 17.5 gallons per person per shower planning factor provides a built-in allowance of approximately 15% for noncompliance. That is, 50 seconds or 2.5 gallons of water per person per shower is allotted for those who refuse to comply with the established shower allowances. Although this quantity certainly can not be considered excessive, it does provide the population with a slightly less restrictive allowance and a more common time increment than the Services planning factor. The derived quantity also has the added advantage that it still complies with the Services'

seven minute shower rule. It is important to note that increased water consumption can be used as a means to build morale so, the planning factors developed will allow the Commanders to determine how many showers, therefore how much water, will be allotted to the population on a daily basis. Table 3.7 lists a sample of the planning factors developed while Table H.5 in Appendix H summarizes all the planning factors developed for hygiene requirements.

	Water Needs (gals per person per day)		
Category	Minimum[1]	Minimum + 1 shower per week	Minimum + 1 shower per day
Males	1.7	4.2	19.2
Females	1	3.5	18.5

[1] Should not be used for more than 7 days

Table 3.7. Daily Water Requirements for Hygiene.

The water requirements for laundry are derived much like the requirements for hygiene water. The military requirements only allow water for one load of laundry per week which may not be sufficient for a civilian population recovering from a disaster. Often the recipient population only has a day or two worth of clothing so, they require more frequent laundering of their belongings. Furthermore, many locations where humanitarian operations will be conducted do not accommodate traditional laundry facilities or the recipient population is not familiar with technological advances like washing machines. This results in hand laundering. Although hand washing usually requires less water than washing machines, there is no way to control the usage of water if hand washing is required.

The results of the literature search again indicate that 17.5 gallons of water is used by the average washing machine. [Ref. 31: p. 15] This figure is somewhat higher than the Services' planning factor of 14.7 gallons per load. Therefore, if washing machines are available to the victim population, 17.5 gallons per load will be the planning

factor. The actual gallons per person will be based on the availability of clothing to the victims. For instance, if the victim population is only provided one change of clothing, provisions need to be made to allow more frequent laundering. To complete the discussion on the water requirements for laundry, an assumption needs to be made. The assumption is that several people, perhaps families, do laundry together. This assumption is essential because more frequent laundering implies smaller loads. If several people combine their clothing to make a full load, the required number of wash loads is reduced. For example, if three people combine their laundry which requires laundering every other day, they need to wash three or four loads of laundry and use as much as 70 gallons of water each week. If four loads are washed a week, the planning factor remains 17.5 gallons per person per week (one load per person) or 2.5 gallons per person per day. A similar argument can be used to estimate the water requirements for handwashing. As a final note, potable water is not required for laundry and the rinse water may be recycled and used as wash water. [Ref. 33: p. F-1]

In determining the water requirements for medical treatment, the physical condition of the recipients is the primary consideration. Physical condition is important because illnesses in which fever, vomiting, and/or diarrhea are present can rapidly result in dehydration. This is particularly true of infants, children and older individuals. Furthermore, increased water supplies may be required if the victims have received a large number of injuries. This is to compensate for the fluids lost as a result of their injuries. The planning factor that is developed for medical treatment will be broken into two parts: heat treatment requirements and medical treatment facility requirements. The heat treatment portion is used for heat related casualities or ailments and is generally limited to desert climates. The current military planning factor of .2 gallons per person will be used. This planning factor is acceptable because it was derived under worst case conditions where the troops are unclimatized. [Ref. 32: p. B-1] Since it is unlikely that the activity level of the recipient population will exceed the activity level of those administering the aid, the current planning factor is believed to be sufficient.

If medical services are to be provided, the Academy of Health Sciences recommends a planning factor of 24.4 gallons per patient per day be used for the care and cleaning of patients and associated equipment. [Ref. 32: p. G-2] There are several uses of the water included in this planning factor. Three of the uses are drinking (one gallon), showers (4 gallons), and food preparation (1.5 gallons). [Ref. 32: p. G-3] Since the model has already accounted for uses, the uses and their respective planning factors will be omitted from the recommended planning factor. The resulting planning factor is 17.9 gallons per bed per day. To convert this planning factor into a per person per day quantity, research was required regarding the allocation of hospital beds. The majority of the documentation on this subject indicates that the bed allocation policy depends on anticipated patient load, the evacuation policy in the operating area, and the average length of stay of the patients. [Ref. 29: p. 5-8] Unfortunately, none of this information is known before a humanitarian operation is conducted.

In an effort to address the allocation of hospital beds in general, field manuals on health services in the theater of operations were obtained. Since the type of care required during these operations is believed to model that administered by a traditional hospital rather than hospitals found in a combat zone, data on a general hospital was used for the computations. The FM 8-10 shows that a general hospital is allocated one per supported division. [Ref. 35: p. B-3] The average end strength of a division is 15,500 personnel; and, a notional corps support command includes over 22,000 personnel. [Ref. 36: pp. A-1 - A-10] Assuming there are four divisions in a corps implies the support structure for a division has approximately 5500. Combining the average division strength with the support structure strength would indicate that a supported division includes approximately 21,000 people. The general hospital is a 476-bed facility; so, .02 general hospital beds are allocated per person (two beds for every 100 people) in the operating area. Finally, multiplying the bed allocation rate by the water requirement per bed results in a .358 gallons per person per day requirement for medical treatment facilities.

It should be noted that it is unlikely a field hospital will be dispatched to support a humanitarian operation. In fact, it is more likely that a more mobile type of unit, like a Mobile Army Surgical Hospital (MASH), will be dispatched for these operations. Using the same argument previously discussed, a MASH has a .012 bed per person allotment rate. However, if a MASH were used to support a humanitarian operation, the type of services required by the unit would be indicative of a general hospital rather than the traditional emergency resuscitative services; so, the .02 beds per person allocation would correspond to the different workload.

In regards to food preparations, the water requirements are menu dependent rather than population dependent. The Services planning factors state that when serving an MRE no water is needed to prepare a meal [Ref. 30: p. 2-8]; however, anyone who has eaten an MRE will agree that water is required to prepare the drink. For this reason, when a MRE is being served, a .25 gallons per person planning factor will be provided. The field manuals also state that, when full kitchen services are provided, as much as 4.5 gallons per person per day can be required. [Ref. 30: p. 2-8] Although the specific menu affects the exact water requirements, the 4.5 gallons per person is sufficient for gross planning requirements. However, some operations do not serve three prepared meals a day so the planning factor needs to be a per meal quantity. Unfortunately, the current manuals do not adequately describe the breakdown of the food preparation planning factor. Inferred by the definition of a planning factor is that the factor includes sufficient water to prepare a day's worth of meals and to complete the necessary kitchen sanitation after the meals. If three MREs are served the minimum requirement of zero is attained. If the assumptions are made that the kitchen must be cleaned between meals and that the maximum planning factor is comprised of three kitchen prepared meals, the per meal factor of 1.5 gallons per person is attained. After reviewing a variety of sample menus provided by the Navy Food Management Team, this figure can successfully be reduced to one gallon per person per meal for food preparation with .5 gallons per person per meal allotted for kitchen sanitation.

The remaining category, waste, can be taken directly from the planning factors derived by the Services. The primary sources of waste are excessive use by the recipient population, overfilling holding tanks, pipe or storage tanks leaks. Regardless of the recipient population, overflow, and leak rates will remain fairly constant. The Services figure will suffice because the primary source of water waste experienced in Humanitarian operation, excessive use, has been reviewed and the associated planning factors have been developed to compensate for a non-military population. The current factor for waste is ten percent of the total water requirement. Although the planning factor for waste is believed to be excessive, especially since this model has already provided substantial water allowances, it certainly would adequately address the aggregated requirements until operational data can be obtained by the JTF.

The final consideration for Class I supplies is eating utensils. Fortunately, there is very little variation in the required items. Regardless of the operation, if cooked meals are to be served, eating utensils are required. Although the manufacturer many vary, the types of eating utensils are somewhat standardized from operation to operation. Past operations illustrate that a plate, cup, utensils, and napkins will be distributed with cooked meals. When MRE's are served there is no need for additional eating utensils, so no planning factor will be derived.

To attain a valid logistics planning factor, the Federal Supply Center was contacted. [Ref. 37] Each of the required item's shipping data was retrieved from the Federal Stock System's computer. Then, the bulk weights were transformed into per item weights by simply dividing the bulk weight by the bulk quantity. Finally, all the per item weights for similar items were averaged together to develop a planning factor of each item. Because the items distributed are menu driven, each item will have its own planning factor. The planner can then determine what utensils will be issued. Table 3.8 summarizes the logistics planning factors for eating utensils that are provide by this model.

Item	Pounds Per Item
Plate	0.038
Napkins	0.005
Cups.	0.014
Forks	0.0165
Knives	0.0167
Spoon	0.0122

Table 3.8. Planning Factors for Eating Utensils Included in the Model

b. Class II - Personal Supplies.

Class II supplies include all clothing, individual equipment, tents, and housekeeping supplies. In many cases, not all types of Class II supplies are required. For instance, homeless hurricane victims may only require housing as they may have been able to salvage ample clothing. In another scenario, the infrastructure may be able to house the homeless but is unable to clothe them. Considering these are only two possible scenarios and each has very different needs, each major division of personal supplies will be derived separately.

If clothing is to be provided, the goal is to adequately address the immediate needs of the population. In the worst case, where the Services are tasked to completely clothe the population, a shirt, pants, undergarments, shoes, and a jacket (should the climate dictate the requirement), will satisfactorily clothe the recipient population. For extremely brief operations (less than a week), a single issue of clothing should suffice. However, as the duration increases, the number of issues should also increase. The reason is two-fold. First, a single issue of clothing does not allow for a weekly change of clothes which is recommended by the Office of the Surgeon General. [Ref. 32: p. D-2] Secondly, the life cycle of an item is assumed to increase when its use decreases. Personal equipment, on the other hand, can be considered to be items that provide additional comfort to the recipient population. Personal equipment includes cots, blankets, towels, pillows, and a variety of additional items which can make the recipient population feel more comfortable.

The methodology used to develop the clothing and the personal equipment planning factors is very similar to that used for eating utensils. The main difference is that for Class II items some assumptions were made. The assumptions involve the life cycle of each item. Because of the nature of humanitarian operations and the amount of wear each item will receive, the items are not expected to have a very long life cycle. This model will assume the life cycle of cloth clothing items, like a shirt or shorts, will be two months. For shoes, the life cycle depends on the durability of the item. Sneakers are assumed to have a three month life cycle, boots (or a strong shoe) a six month life cycle, and flip-flops or sandals a two month life cycle. In addition, it is assumed that the life cycle of an item will increase if additional items of the same type are provided. For instance, if two shirts are provided, the life cycle of each shirt is assumed to increase to four months. If three shirts are provided, the life cycle increases to six month, and so on. Table 3.9 summarizes the weights and life cycles used for each clothing item for both warm and cold climates.

To determine the per person per day planning factor for each item, the item's weight, I_W, is divided by the life cycle of the item, I_{LC}. For instance, to determine the per person per day planning factor for a man's shirt in a desert or tropical climate the following calculation would take place

$$= I_W / I_{LC} \tag{3.5}$$

$$= .125/60 \tag{3.6}$$

$$= .002. \tag{3.7}$$

For temperate climates, this planning factor would be increased by ten percent to accommodate the larger temperature variation. The calculations for a cold climate are done the same way as those for a desert or tropical except that the item weights are extracted from the cold climate portion of Table 3.9. Finally, arctic planning factors are derived by increasing the cold climate factors by ten percent. Table H.11 in Appendix H summarizes the baseline planning factors for warm and cold climates.

Item	Life Cycle	Men	Women	Children	Infants
		Warm Climate Clothing			
shirts	60	0.500	0.400	0.300	0.100
shorts	60	0.500	0.450	0.400	N/A
underwear	60	0.125	0.100	0.070	N/A
bras	60	N/A	0.250	N/A	N/A
socks	60	0.180	0.150	0.080	0.017
sneakers	90	2.000	1.750	1.500	1.000
flip-flops	60	0.400	0.300	0.200	N/A
		Cold Climate Clothing			
shirts	60	1.200	1.000	0.600	0.500
pants	60	1.200	1.000	0.600	0.500
thermal	60	1.200	1.150	0.600	0.250
socks	60	0.250	0.200	0.100	0.080
jacket	365	4.000	3.500	2.800	1.750
boots	180	4.500	4.000	3.000	N/A
gloves	90	0.500	0.400	0.300	0.250

Table 3.9. Summary of Data Used to Derive the Class II Clothing Planning Factors

The calculations for personal equipment follow the calculations for clothing items very closely. The main differences are reduced variation due to climate and reduced variation due to demographics. In this model, only one personal equipment item will be altered in response to the climate. The one item is a blanket. The need for increased blanket weight as the temperature drops is understandable. Therefore, the following variations will be included: blanket weight for a desert or tropical climate remains constant; blanket weight for a temperate climate increases by ten percent; blanket weight for a cold climate is increased by twenty percent; and blanket weight for an arctic climate is increased by thirty percent. Also, only one demographic group will maintain separate planning factors for personal equipment, infants. Because infants are so small and are so dependent on adults, many items are not required by infants. The weight for a cot is maintained because it is believed that a cot could suffice in the absence of a crib. However, if infant specific items are unavailable, the general populous items will suffice. The individual items' planning factors are summarized in Table 3.10.

Item	Life Cycle	Weight per item[1]	Planning Factor[1]	Weight per item[2]	Planning Factor[2]
cot	365	10	0.0274	10	0.0274
blanket	365	2	0.0055	0.5	0.0014
sheets	180	1	0.0056	0.5	0.0028
pillow	365	1	0.0027	N/A	N/A
pillowcase	180	0.2	0.0011	N/A	N/A
bucket	365	0.8	0.0022	2[3]	0.0055
towel	180	0.5	0.0028	0.4	0.0022
washcloth	180	0.0625	0.0003	0.05	0.0003
rain coat	180	0.6	0.0033	N/A	N/A

[1] For general population. [2] For infants. [3] Small tub for bathing infants

Table 3.10. Baseline Weights and Planning Factors for Class II, Personal Equipment

Computations for tents are much more straightforward. Tent weights are extracted directly from military manuals. [Ref. 38 : B-17] For warmer climates, a General Purpose Medium Tent which houses 12 people was selected. It was chosen over the larger version to offer more privacy to those housed in the tent. The planner has the option to include a tent liner or not. For cold climate, a ten man arctic tent was selected. Now that the weight of the tents are defined as well as the number of personnel each houses, the development of a planning factor is simply the division of the tent weight by the number the tent houses. The results are summarized in Table 3.11.

Tent	Houses	Total Weight	Planning Factor
GP, Medium	12	455	37.92
GP, Medium w/Liner	12	545	45.42
Arctic	10	76	7.60

Table 3.11. Baseline Weights and Planning Factors for Class II, Tents

As for housekeeping supplies, the primary concern is for items used directly by the victim population. That is, there may be many other items required for housekeeping, like sanitizer for the toilets, but they will be included in construction materials since they are not actually maintained by the population but rather relate to items

that are brought into the area, built by, or maintained by the JTF. There are only two items believed necessary to distribute to the population itself, trash bags and laundry soap. A maximum of one standard trash bag per person per day will be provided which amounts to one ounce per person day or .0625 pounds per person per day. For laundry soap, a planning factor of one cup of soap per load of laundry is provided. Therefore, the soap requirements hinge on the laundry policy established. If one load of laundry per week is allotted, a planning factor of .5 pounds per person per week or .0714 pounds per day is required. If two loads of laundry a week are planned, a planning factor of a pound per person per week or .143 pounds per person per day is required.

Finally, the reader should be aware that although the computations of logistics planning factors for Class II supplies were successfully calculated to adhere to the Army's traditional units of measure, it is unlikely that the pounds per person quantity is the most useful unit of measure. This is because the items in question wear at the rate identified by the planning factor rather than being consumed at that rate. The items are distributed as a whole so, the logistician might find the unit weight more helpful. If the unit weight is used, the life cycle of the item can be used as a resupply interval. That is, if two shirt are issued on day one of an operation, the planner can prepare for the possibility of replacing the two shirts on day 120.

c. Class III - POL.

The planning factors for Class III are derived directly from the current fuel planning factors used by the services. The requirements are broken into two categories: packaged petroleum products and bulk fuels. It is assumed that the number of different types of fuels and petroleum products that will be used will be kept to a minimum to reduce the problems associated with handling and storage of this volatile commodity. The planning factor used by the services to determine the consumption rate of packaged POL products is .59 pounds per person per day. However, this figure is based on wartime operations and includes the requirements for tanks and aircraft. Since it is believed that wartime consumption would greatly exceed the requirements of humanitarian operations

and since aircraft are not considered in this model, the services' planning factor will be cut in half to address the requirements for humanitarian operations. The resulting packaged POL planning that will be used for this model is .295 pounds per person per day. Although it is believed that this figure is still excessive, it will adequately reflect the worst case scenario.

The requirements for bulk fuel are derived from the number of fuel consuming equipment items maintained in the theater of operations and the consumption rate of the equipment. Table 3.12 identifies the major equipment items included in the model, each equipment's fuel usage rate, and the type of fuel the equipment uses. To determine the fuel requirements for any one equipment type, F_i, equation 3.8 can be used. In the equation, the total number of a particular equipment type, E_i, is multiplied by the equipment's fuel usage rate, UR_i, and the number of miles or hours of usage the equipment provides each day, $EOps_i$.

$$F_i = E_i * Ur_i * Eops_i \qquad (3.8)$$

Once the fuel requirements for each individual item have been considered the total fuel requirements, *TF*, can be calculated by summing the fuel requirements for each of the individual items. Finally, the Class III planning factor is derived by dividing the total bulk fuel requirements, *TF*, by the number of people being supported, *PS*, and then adding in the packaged POL planning factor, *POL*, as illustrated in equation 3.9.

$$FPF = (TF / PS) + POL \qquad (3.9)$$

Since the actual requirements and fuel consumption rates needed to operate cooking equipment were unknown, several assumption had to be made. First, it will be assumed that cooking equipment, like stoves, will consume fuel at approximately the same rate as heaters. In addition, it will be assumed that the majority of cooking equipment used will be powered by generators and that the fuel consuming equipment is allocated in such a way that one piece of equipment can service 1000 people.

Item	Usage Rate[1]	Gallons Per	Fuel Type
5-Ton Truck	0.1243	Mile	Diesel
6000 Lb. Rough Terrain Forklift	5	Hour	Diesel
Rough Terrain Container Handler	8.5	Hour	Diesel
1000 Gal. Water Transport	0.1243	Mile	Gas
1200 Gal. Fuel Transport	0.0932	Mile	Gas
Sanitation Trucks	0.1243	Mile	Gas
5 - Ton Wrecker	0.2237	Mile	Gas
Garbage Truck	.0621	Mile	Gas
ROWPU	9.4	Hour	Diesel
Refrigerated Container	1.09	Hour	Diesel
Generator	6	Hour	Diesel
Yukon Heater	.63	Hour	Gas
Cooking Equipment	.63	Hour	Gas

[1] [Ref. 29: pp. 2-20 - 2-52]

Table 3.12. Fuel Usage Rates for the Equipment Include in the Model

d. Class IV - Construction Materials.

The first step in determining the construction materials needed is to define the operational requirements. For this model, construction materials will be broken into five categories based on what structures must be built. The categories are housing, latrines, kitchens, storage facilities, and medical facilities (when deployable assets are not provided). Unfortunately, due to the inability to quantify the required items, a modified version of the Services planning factor will be used to address the construction requirements for humanitarian operations and many assumptions will be made.

The immediate concern is to house the homeless. Since humanitarian operations are not designed to be permanent, tents will satisfy the housing requirements and these requirements have already been derived with Class II supplies. The only considerations that remain are clearing the land, tent maintenance, heating requirements, and protective barriers. Clearing the land itself does not require additional supplies, just equipment. [Ref. 29: 1-45] Again, because these operations are not intended to be permanent, it will be assumed that only the land will be cleared, no surfaces will be laid. Tent maintenance will not be a factor until an operation has been going on for some time; in which case, replacement tenting should be considered. In this model, it will be assumed

that tent replacement will not begin until after the operation has been in place for a year. Until that time, the equivalent of a single tent which will serve as a repair kit will be provided for every 50 tents in use or for every 600 homeless people. After a year, the operational Commander and his staff must determine whether to begin a replacement cycle or continue tent maintenance. In either case, the baseline planning factor will be the tent weights discussed in the Class II requirements section.

Heating requirements are only a consideration in the cooler climates. The GP Medium tent previously discussed can accommodate two heaters while the 10-man arctic tent can only accommodate a single heater. [Ref. 38: p. B-17] These figures will serve as the allocation rate. In addition, there is a general desire to keep the number of fuel commodities to a minimum, so fuel burning heaters or stoves will be used to heat the tents. In this model, the M1950 Yukon heater will be considered. The actual weight of a Yukon heater is unknown. The weight that will be used is 35 pounds which equates to 2.92 pounds per homeless person when using GP Medium tents and 3.5 pounds per homeless person when using the 10-man arctic tents (the weight of the heater and the associated planning factors can be updated in the model when the true weight is located).

Protective barriers only need to be considered when population safety is a concern. The Services use a planning factor of 4.0 pounds per person per day for protective barrier and fortification material. Since humanitarian operations are stationary operation, it is not believed that a daily resupply is necessary. However, it is also believed that 4.0 pounds per person will not adequately address the requirements due to the weight of traditional fortification materials. Expedient barbed concertina wire weighs approximately 56 pounds per 50 foot roll which is approximately 1.12 pounds per foot of wire. [Ref. 39. p. 108] It will be assumed that a single roll will be able to cover three linear feet and each person will be allotted three linear feet. This assumption is based on concertina wire being erected with a four foot diameter and four feet to interconnect each successive loop. With this assumption, each member of the supported population will

require approximately 50 feet of concertina wire or 56 pounds. Therefore, the requirement for barrier materials will be 56 pounds per homeless person.

Latrines are comprised of two components: restrooms and bathing facilities. In the worst case, port-o-lets can be used and they tend to weigh more than traditional temporary restroom facilities. Therefore, port-o-lets will be used in this model. The allocation rate is one port-o-let per twenty supported personnel. At 208 pounds per port-o-let, a per person planning factor of 10.4 pounds can be derived for restroom facilities. [Ref. 40] In addition, .0625 gallons or .5313 pounds of chemicals per port-o-let per week is required for sanitation purposes. [Ref. 40] Bathing facilities have been minimal in the past and it is believed that the limited availability of bathing facilities is designed to reduce the overall consumption of water. With this in mind, one shower head will be provided for every 500 homeless people supported. After reviewing the blueprints of several small and temporary bathing facilities, it is estimated that each shower stall will require approximately 1500 pounds of supplies. The estimate is based on known weights of piping, screws, nails, and plywood. All other weights were estimated using the advice of local merchandisers. Using the allocation rate of one shower head for every 500 homeless people, the 1500 pounds of supplies breaks down to three pounds per person.

Kitchen facilities will require a large amount of supplies. The actual quantity is believed to exceed the requirements for shower facilities as a kitchen requires similar plumbing supplies as well as large quantities of galley equipment. Until more detailed weights can be obtained, this model will allow six pounds per person in need of assistance, twice the planning factor for showers, to construct kitchen facilities.

The requirements for storage facilities depend greatly on the amount of supplies in theater and the percentage of the supplies that require storage. This model will use the estimated storage rates developed by the Services. The Services have developed gross storage factors for the various classes of supply which are summarized in Table 3.13. To obtain the total square feet of storage required equation 3.10 is used. [Ref. 29:p. 1-41]

$$\begin{array}{l} \textit{gross} \\ \textit{storage} \\ \textit{factor} \end{array} \times \textit{population} \times \begin{array}{c} \textit{storage} \\ \textit{covered} \\ \textit{(days)} \end{array} = \begin{array}{l} \textit{sq. ft of} \\ \textit{covered} \\ \textit{storage} \end{array} \qquad (3.10)$$

Once the total square footage required is determined, the number of storage tents needed can be calculated by dividing by 358, the square footage available in a storage tent. [Ref. 38: p B-17] Then, the actual planning factor can be determined by multiplying the required number of tents by 402, the weight of an individual storage tent. Finally, dividing by the population size will determine the per person requirements for storage space.

Supply Class	Gross Storage Factor (sq. ft/person/day)
Class I	0.0353
Class II	0.0169
Class III	0.0005
Class IV	0.0073
Class VI	0.0248
Class VII	0.0055
Class VIII	0.0054
Class X	0.0169

Table 3.13. Gross Storage Rates [After Ref. 29: p. 1-41]

If deployable medical units are not used, some considerations need to be made for medical facilities. The bed allocation rate derived in the Class I section of this thesis will be used. The planner should determine the number of beds required by multiplying the size of the population by the appropriate bed allocation rate. For every twenty beds required, one hospital ward tent, twenty cots and three heaters, when applicable, will be allotted. In warm climates, this equates to approximately 45 pounds per bed while in cool climates it equates to approximately 50 pounds per bed. Using the initial load list for an Air Transportable Hospital, it was determined that each bed requires approximately 480 pounds of medical equipment (large equipment like generators not considered here). Therefore, the planning factor for medical facilities in warm climates will be 525 pounds per bed and 530 pounds per bed in cool climates. For an operation

exceeding six months, this planning factor will be increased by 50 percent to account for upgraded facilities including plumbing and air-conditioning.

Although only minimally addressed by this model, the planner should not rule out the necessity to provide materials to maintain the structures that have been built or the construction equipment required to build the structures. The need for structural maintenance becomes apparent during the longer duration operations. Fortunately, the requirements for structural repairs will not be a major factor in the planning effort until several months have passed. This allows the planner to consult the appropriate engineers and construction battalions to properly assess the necessary requirements. Moreover, once the planner has determined what structures are required to support the population, the engineers can provide the planner guidance regarding the type of equipment required.

e. Class VI - Hygiene Items.

The primary difference between the Service's derived planning factor for Class VI items and the planning factor derived for this model is what is actually included in the class of supply. The planning factor derived for this model contains only items relating to the personal hygiene of the recipient population. Included in the Service's figure are allotments for items like civilian clothing, camera equipment, and stationary supplies. For humanitarian operations, these items are considered excessive; primarily, because the goal of these operations is to provide life-saving aid. Although shampoo, soap, and toothpaste are unlikely to save a life, they are some of the items considered basic requirements to maintain personel hygiene. For this model, all the other items traditionally included in this class of supply will be incorporated into Class X.

The basic hygiene products that are included in this model are soap, shampoo, a toothbrush, toothpaste, deodorant, shaving cream, a razor, toilet paper, a comb or a brush, and feminine hygiene products. In some countries, alternate hygiene items may be more appropriate. For instance, some countries use items similar to toothpicks, rather than toothbrushes, for dental hygiene while other countries do not believe in shaving. As long as planners are aware of the items included in the planning

factor and the items' contribution to the planning factor, they can compensate accordingly. The planning factors derived for Class VI employ a methodology very similar to the methodology used to derive the planning factors for the utensils portion of Class I and Class II. The difference is that the manufacturers were contacted to determine average "serving size" for each of the products rather than a life cycle. The manufacturers' customer service representatives provided the average number of uses in a standard size item. This data was quickly converted into average quantity consumed per use and the average number of days any one item can be used. Combining the expected daily usage with the average quantity consumed per use resulted in the derivation of the average quantity used per day.

For example, Crest® representatives offered data on the 181 gram tube of toothpaste and the 132 gram tube. The smaller tube provides sufficient paste for 100 brushings while the larger tube provides sufficient paste for 135 brushings. The usage rate is computed by dividing the weight of the product, 132 grams, by the number of "servings" in the product, 100, which equated to approximately 1.32 grams per brushing for both tubes. Assuming each person will brush their teeth after each meal, a 132 gram tube of toothpaste will provide 33.33 days of supply. By dividing the weight of the product, 132 grams, by the days of supply the product provides, 33.33 days, results in a daily usage rate of 3.96 grams. A ten percent allowance was then provided for error that can be experienced due to excessive use and waste while varying allowances from one percent to ten percent were allotted to accommodate for product packaging. The reason for varying the allowances for packaging is general knowledge of the products' packaging. For instance, a shaving cream can certainly outweighs the plastic or paper wrap that holds toilet paper. Therefore, shaving cream has a ten percent allowance for packaging while toilet paper has only a one percent allowance. Continuing the toothpaste example, the error allowance equals .40 grams and the one percent packaging allowance is .04 grams for a total of .44 grams of additional weight. Adding the .44 grams to the daily usage rate of 3.96 results in a planning factor of 5.4 grams. Finally, the total planning factor for

toothpaste, 5.4 grams, has to be converted into pounds. The new planning factor equates to .0118 pounds per person per day. A summary of the data and the initial computations is found in Table 3.14.

Once the planning factors for the individual items were calculated, they had to be aggregated into planning factors for the various demographic groups. The following assumption were made in the aggregation: men do not need feminine hygiene products; women do not need shaving cream; children do not require shaving items, feminine hygiene products, or deodorant, and infants only require shampoo, soap and a comb. The resulting planning factors are summarized in Table 3.15. Note that the planning factor for infants exceeds the amount allotted for shampoo, soap, and a comb. This is to allow for items that may be required by infants due to the sensitivity of their skin, like powder and lotion.

Item	Size of item	Number of uses	Number of days of use	Average quantity per use	Average quantity per day	Packaging and error allowances	Planning Factors
	gms			*gms*	*gms*	*gms*	*gms*
toothpaste	132	100	33.33	1.32	3.96	0.44	5.4
toothbrush	10	90	30	0.11	0.33	0.04	1.37
shampoo	457.6	40	40	11.44	11.44	1.26	14.7
deodorant	48	60	60	0.80	0.80	0.09	2.89
soap	143	30	15	4.77	9.53	1.05	11.58
shaving cream	228.8	60	60	3.81	3.81	0.42	14.23
comb	10	120	60	0.08	0.17	0.02	1.185
brush	85.8	120	60	0.72	1.43	0.16	11.59
razor	5	5	5	1.00	1.00	0.11	2.11
toilet paper	171.6	40	10	4.29	17.16	1.89	20.05
feminine hygiene	343.2	28	28	12.26	12.26	1.35	13.61

Table 3.14. Summary of Data and Computations used derive Class VI Planning Factors

Category	Planning Factor[1]
Infants	0.0921
Children	0.1186
Women	0.1774
Men	0.1606

[1] Pounds per person per day

Table 3.15. Planning Factors for Class VI Items

It is important to note that Class VI items, much like Class II items, are not issued in terms of their planning factor. For instance, no one is going to issue .026 pounds of soap. These figures are used for planning purpose only. The initial surge rate will be based on the size of the items issued. If all the supplies ordered for an operation corresponded in size to the products used to derive the Class VI planning factor in this model, an initial issue of 2.64 pounds per man would be required. The resupply intervals would correspond with the number of days of supply that each item provides. In the toothpaste example, the resupply interval would be every 33.33 days. Again, the traditional pounds per person per day planning factor is included to parallel the Class VI planning factor currently used by the Services.

Finally, for extended duration operations, planners may consider augmenting this class of supply. In cultures where personal hygiene is very important, a great increase in morale and quality of life can be experienced among the victims at relatively little cost to the Government.

f. Class VII - Support Equipment.

Class VII items include all the equipment required to support the victim population. The major equipment items included are trucks used to transport the population and supplies, electricity generating equipment, and water generating equipment. The need for equipment is based on the size of population being supported, the amount of supplies required, the distance that must be traveled, and the condition of the infrastructure. Once the planner has determined what supplies are needed, the Services have already established calculations for determining the equipment required. The Services' calculations will be used in this thesis.

To begin the calculations a few assumptions must be made. First, it is assumed that the equipment will be available a minimum of 80% of the time. It is also assumed that the cargo to be transported can be loaded to the weight capacity of the vehicle without exceeding the size or cube capacity of the vehicle. That is, if a truck is rated for loads up to 10 tons, 10 tons of supplies can be loaded into the vehicle regardless of the size of the object. It is assumed that the round trip journey from the supply storage area to the distribution area is less than 180 miles and that supplies and personnel will be transported using motor vehicles.

The transport vehicle used in this model is a five-ton cargo truck. It was chosen because it is a very common vehicle with a reasonable cargo capacity. To compute the required number of vehicles several things need to be known. First, the amount cargo, supplies or personnel, to be transported needs to be calculated. Therefore, this is one of the last classes of supply to be considered. Once the amount of cargo that needs to be transported has been identified, the one way distance in miles to be traveled, *Dist*, the speed of travel in miles per hour, *S*, and any number of hours of delays in the transit time, *Delays*, need to be determined to calculate the turnaround time of a vehicle, *TA*. The turnaround time is computed as follows

$$TA = ((2 * Dist) / S) + Delays. \qquad (3.11)$$

and it is measured in hours. [Ref. 38:p. 3-23] Next, the length of the operational day for the vehicles in hours, *VOps*, needs to be identified. Then, the tonnage or the number of personnel the vehicle can transport, *VCap*, needs to be identified. *VCap* for the items included in this model can be found in Table 3.16. Once these items are identified the number of vehicles required to transport supplies in the theater, V_c, can be calculated using equation (3.12) where T_c is the number of short tons to be transported. The same equation can be used to calculate the number of vehicles needed to transport personnel, V_p, but T_c is replaced with T_p, the number of personnel to be transported.

$$V_c = (T_c * TA) / (VCap * Vops) \text{ [Ref. 38:p. 3-23]} \qquad (3.12)$$

When computing the requirements for water or fuel trucks, equation 3.12 can also be used. However, T_c and *VCap* are both measured in gallons.

It is interesting to note that there is a circular relationship between fuel transports and fuel required. That is, identifying the need for fuel transports also identifies the need for additional fuel which in turn requires additional fuel transports. Fortunately, the requirements eventually converge as the additional fuel requirements sustained by adding more transports is absorbed by the remaining storage space of the fuel transports previously calculated.

Item	Item Weight	Capacity
5-Ton Truck	22000	6 STONS
6000 Lb. Rough Terrain Forklift	27100	3 STONS
Rough Terrain Container Handler	105120	25 STONS
1000 Gal. Water Transport	14500	1000 Gallons
1200 Gal. Fuel Transport	15000	1200 Gallons
Sanitation Trucks	14500	1000 Gallons
5 - Ton Wrecker	34400	N/A
Garbage Truck	36000[1]	N/A
ROWPU	37960	60000 Gallons
Refrigerated Container	4000	41300 Pounds
Generator	7540	60 KW

[1] Estimated weight

Table 3.16. Equipment Included in the Model and their Weights and Capacities

The number of forklifts required, *FL*, is a function of the tonnage of supplies to be moved each day, T_c, and the number of tons the forklift can move in a day. It has been determined that a forklift can load and unload 120 pallets per day. [Ref. 41] In addition, it is assumed that average pallet holds one short ton. The formula used to derive the forklift requirements is

$$FL = T_c / 120. \qquad (3.13)$$

The water production/purification equipment requirements, WPE_R, are based on the quantity of water required each day, W_R, the infrastructure's ability to generate water each day, I_a, the speed at which the water can be produced, P_s, and the

number of hours the equipment operates each day, W_o. I_a is the percentage of the total water requirement, W_R, the infrastructure is capable of producing. P_s is measured in gallons per hour while W_R is measured in gallons per day. The formula that is used to compute the number of water producing or purifying machines is as follows

$$WPE_R = W_R * (1-I_a) / P_s * W_o. \qquad (3.14)$$

In this model, the wrecker requirements are based on the number of vehicles in the theater. That is, one wrecker will be allocated for every one hundred vehicles in the theater of operations. Similarly, one container handler will be allocated for every fifty containers in the theater and one garbage truck will be allotted for every 25,000 people.

Generator requirements are traditionally based upon the theater energy requirements. Unfortunately, there is no way to identify the actual quantity of energy a humanitarian operation is likely to require. However, it can be assumed that the operations will use as little energy as possible. The historical review has identified that the primary uses for the generators are cooking, security lighting, and water distribution. Therefore, it seems reasonable to use an allocation policy based on the size of the population being supported and the condition of the infrastructure. To establish an allocation rate, several of the Services' deployable assets were reviewed. A fully functional medical facility capable of supporting a medical surge of 150 people, requires only a single five kilowatt (KW) generator with an identical back-up. [Ref. 42: P.77-78] Traditionally medical facilities require a great deal of energy due to the nature of their mission, so using a similar allocation rate would surely satisfy the minimal energy requirements of a population being supported during humanitarian operations. With the knowledge that this model will be using 60KW generators, the allocation policy will be as follows. If the infrastructure is functional, one generator will be issued for every 1800 people. If the infrastructure is damaged, one generator will be issued for every 900 people supported. If the no infrastructure exists, one generator will be issued for every 450 people.

The need for refrigerated containers is driven by the number of meals served each day, the quantity of medical supplies requiring refrigeration, and the condition of the infrastructure. For instance, when a meal is prepared in the theater with a non-existent infrastructure, it is assumed that twenty percent of the food requires refrigeration. When the infrastructure is only damaged this figure drops to ten percent because it is believed that the infrastructure has the means to refrigerate the remaining ten percent. If the infrastructure is functional, ample refrigerated containers to house five percent of the served food will be allotted. If all the meals being served are MRE's, there is essentially no need for refrigeration other than that required for milk. To accommodate the refrigeration of milk, the same infrastructure variations will apply but the refrigeration rates will be applied to only one-sixth of the total food requirements. That is, if three MRE's, which equates to 4.41 pounds per person, are served in an area with a functional infrastructure, the twenty percent refrigeration rate will be applied to only .735 pounds of the total per person food requirement. Finally, it is assumed that all deployable medical assets will be deployed with ample refrigeration facilities to handle any self-generated requirements. When medical facilities are built, it is assumed the refrigeration requirements are built into the construction materials planning factor previously discussed.

Once the planner has determined the total number of each item required, all these number should be increased by twenty percent to allow for maintenance and down time. This is done by multiplying the total number required by 1.2. Once these calculations are completed the total weight of the required equipment, T_w, is calculated as follows

$$T_w = \sum_{All\ i} (N_i * W_i) \tag{3.15}$$

where N_i is the total number of equipment i and W_i is the weight of equipment i, which can be extracted from Table 3.16. Finally the planning factor for support equipment can be calculated by dividing T_w by the size of the population. It is important to note that this planning factor is a one time requirement. That is, there is no sustainment rate. In

addition, the requirements for support equipment will be the greatest when handling the initial surge requirements so they should be calculated based on the surge requirements.

g. Class VIII - Medical Supplies.

This class of supply includes all the medical materials required to support the victims of a disaster. To establish the planning factor, several things must be considered: whether medical services will be provided; the level of medical service to be provided; whether the medical services being rendered are supplemental or complete in nature; and the current physical condition of the population being supported. Again, there is no way to predict the demand before the execution of a humanitarian operation. This is because demand depends on all aspects of the population's physical condition. Therefore, the planning factor will be based on "notional" requirements using the same arguments described when deriving the water requirements for medical services.

The worst case scenario, where the services must provide complete medical care to a severely injured population, will be considered first. Again using a general hospital as a baseline, the amount of supplies used on a daily basis when in an operational status must be determined. Fortunately, a recent document generated by the Academy of Health Services has determined the average daily usage of supplies by a general hospital using historical data. [Ref. 43] The Academy's findings indicate that general hospitals use an average of 33589.416 pounds of supplies a day. As previously noted, a general hospital is a 476 bed facility. Dividing the total consumption of supplies of the hospital, TC, by the number of beds in the hospital, B, results in the planning factor for the amount of medical supplies required per bed, $MSPF_b$. That is,

$$MSPF_b = TC / B \tag{3.16}$$

or in this case

$$MSPF_b = 33589.416 / 476 \tag{3.17}$$

which equals 70.566 pounds of supplies per bed per day. The maximum bed allocation rate was already determined to be .02 beds per person. So, the medical supplies planning factor, $MSPF_p$, can be determined by multiplying the $MSPF_b$ by the bed allocation rate

which results in a 1.41 pounds per person per day factor. This planning factor should adequately address the needs of the victim population in the worst case scenario since, much like a combat zone, an area struck by a disaster may be quickly inundated with casualties.

There is one demographic group that requires special consideration when determining Class VIII requirements. The group is infants. Many supplies required by infants are now being requisitioned with medical supplies. [Ref. 43] These supplies include formula, bottles, and diapers. Formula has been included in the nutritional requirements and will not be reconsidered here. However, to accommodate some of the special needs of infants an additional allotment of 12 ounces or .75 pounds per day will be included in the planning factor for medical supplies provided for infants. The quantity includes eight diapers per day per infant, bottle liners, bottles, pacifiers, and teething rings. Of course, each item's planning factor, except diapers, is calculated using the life cycle method described in Class II supply requirements.

Regardless of the extent of medical services the military provides or the physical condition of the population, the maximum planning factor should be able to address all the medical requirements for the worst case scenario. However, when the extent of the services is reduced or when the physical condition of the population being supported is extremely good, the maximum planning factor is likely to be excessive. The most obvious example is when no medical services are provided. Although no medical services are provided, it is believed that a minimal amount of basic first aid supplies will be maintained. A breakdown of the required Class VIII supplies was reviewed to determine the minimal requirements. It is found that 8.1 percent of the daily allowance is used for x-ray film and developing, test kits, and patient care accessories. [Ref. 42] The exact breakdown is unknown but, it is believed that five percent of the daily allowance should accommodate the patient care accessories. Computing five percent of the maximum quantity of supplies required per person, 1.41 pounds, results in a planning factor of .07 pounds per person that can be used to account for basic first aid supplies. By dividing the

supplies per bed, 70.566, by the .07 pounds per person planning factor equates to a beds per person rate of .001 or 1 bed per 1000 people being support. If the .02 beds per person planning factor and the associated medical supplies planning factor were used, it is obvious that a large surplus of supplies would result.

To offer planners a means to differentiate between the various degrees of services that are to be provided, the model offers several bed allocation rates ranging from .001 beds per person when no services are being rendered to .02 beds per person when complete services are being rendered and a high percentage of the population requires medical attention. In this case, a high percent refers to eighty percent of the population or more. The high percentage is believed to correspond to the high patient loads experienced by hospitals in combat zones. [Ref. 29: pp. 5-9 -5-26] As the percentage of the population that requires medical attention decreases, the number of hospital beds required should also decrease. This corresponds directly with the relationship between hospital admission rates and hospital bed requirements found in the Service's methodology for determining bed requirements. [Ref. 29: p 5-10] If the percentage drops below eighty percent but remains above sixty percent, the bed allocation rate drops to 1.5 beds for every 100 people. This may seem like a drastic reduction, but it is important to note that a large majority of the patients seen shortly after a disaster are treated and released. The patients do not fill the hospital beds.

Should the required (or authorized) medical services drop even further, the model accommodates three additional bed allocation rates. The first is one bed for every 100 individuals being supported. This allocation rate is believed to adequately address the medical needs when forty to sixty of the supported population requires medical attention. A bed allocation rate of eight beds per 1000 supported personnel can be used when twenty to forty percent of the population requires medical attention. Finally; a bed allocation rate of five beds for every thousand individuals being supported can be used when supporting populations with few injuries (twenty percent or less) or when administering a wellness clinic. That is, a clinic that provides the every day needs of an otherwise healthy

population (i.e. immunizations, colds, etc.). No documentation can be found to justify a bed allocation rates below .005 when medical services are being provided. Therefore, the final bed allocation rate of .001, which was previously discussed, will be used exclusively for operations that are either not providing medical care or are providing services that equate to distributing aspirin and Band-Aids.

In the event an operation requires the Services to augment existing medical facilities, the medical personnel assigned should coordinate with the local medical personnel to determine what medical supplies, if any, the Services need to supplement and notify the planners as quickly as possible. Finally, because the equipment and shipping requirements for the Services' mobile medical facilities are already thoroughly analyzed in several documents [Ref. 35; Ref. 42], this thesis will not attempt to reevaluate the work completed by medical experts.

h. Class X - Humanitarian Specific Items.

The Army's current planning factor manual states that the supplies included in Class X are materials required to support nonmilitary programs and that a pounds per person per day planning factor is not appropriate. [Ref. 29: p. 2-174] Yet, Service Support Manuals state that Class X includes supplies for civilian relief and supplies for economic aid. [Ref. 44 :p 3-5] This relief and aid can include food, clothing, shelter, and medical supplies; in which case, a pounds per person per day would certainly be appropriate. The Services have chosen not to derive a planning factor for this class of supply. Considering the vast amount of ambiguity surrounding what the class of supply entails, the omission seems reasonable. However, this thesis has taken an entirely different approach to this class of supply. Since all the food, clothing, shelter, and medical supplies have been considered separately, there is no need to consider these items here. In addition, nation building is considered a civic action rather than a humanitarian operation so supplies relating to civic action do not need to be considered either. The question remains as to what is included in Class X supplies.

For this model, Class X supplies are any supplies purchased strictly to enhance the quality of life of the recipients. The supplies can include radios, recreational equipment, school books, religious items, etc. The specific items can vary greatly from operation to operation. Many people are of the thought that anything beyond the essential items (food, clothing, shelter, and medical care) is extravagant and the Services should not be required to accommodate such wastefulness. Regardless of whether the Services should or should not provide such items, provisions should be considered in case a higher authority dictates the purchases. One of the major considerations is when these items should be supplied. Since the goal of the items is to enhance the recipients quality of life, the key is to determine when the population's quality of life becomes an issue. For any short term operation, quality of life is not believed to be an issue. The recipient population is most likely more concerned about living than whether or not they can listen to a radio. Fortunately, most humanitarian operations are short in duration so Class X items do not need to be considered. However, during long term operations, particularly when the recipient population is unable to move about freely, the population gets restless and bored. Restlessness and boredom can manifest into depression, aggression, and various other potentially dangerous emotions. Therefore, the object of Class X supplies is to occupy the minds and souls of the recipient population to avoid security problems.

Any operation that exceeds one month can reasonably consider the purchase of Class X supplies. In considering the items to be purchased, an assumption will be made. The assumption is that the purchases are one time buys. That is, if Class X supplies are to be purchased, they are purchased in bulk with limited considerations for resupply. Much like Class II supplies, a basketball is not consumed on a daily basis. It is purchased once and issued. Therefore, the planning factor will be a per person per issue quantity. If the operation goes on indefinitely, purchase cycles might be considered. For example, every three months supplemental or replacement items can be purchased. Because these items are considered luxury items, they should be kept to a minimum. However, it is preferable that everyone in the population receive something small of their

own to eliminate the possibility of perceived favoritism among individuals in the recipient population. Since at the point Class X items are considered the recipient population is known, they should be consulted as to the recreation sports, games, and activities that are popular in their culture to reduce waste.

The methodology used to derive the planning factors mirrors the methodology used to derive Class II and Class VI items. For Class X, four separate planning factors will be derived: individual items, community items, school items, and resupply items. Individual items are supplies given to everyone in the population, like writing tablets, playing cards, or transistor radios. Community items are supplies like baseball and basketball equipment, art supplies, and sewing materials that are issued on an allotment basis. For example, one complete baseball set will be ordered for every 500 people being supported. School specific items include the necessary supplies to establish temporary schoolhouses like books, notebooks, and pencils and are ordered based on the percentage of the population that requires schooling. Resupply items are items needing regular replacement. For instance, radios need batteries, basketballs need patch kits, and schools run out of paper. The model provides for resupply in thirty day increments. Again, all the factors will be derived with the understanding that these items should be kept to a minimum.

The individual items that are included in the model are radios, writing materials, cards, board games, hats, sunglasses, religious materials, and cigarettes. These items were selected because they are relatively inexpensive and small. In addition, many of the items have universal appeal. Cigarettes will only be issued to a portion of the population which is the size of the adult male population. Religious materials will be distributed to the adults and the remaining items are distributed to all but the infants in the population. The community issue items that are included are baseball equipment, basketball equipment, soccer equipment, sewing equipment and supplies, arts and craft supplies, books, and barber supplies. The items included in the model are designed to give the planner some insight into the types of items that he may consider supplying and are not

intended to be an all-inclusive list. The weights of the items were extracted from the military supply system. When the items were not available through the supply system, commercial manufacturers were contacted to get the necessary shipping weights. Tables 3.17 and 3.18 list the items, weights and resupply items for individual and community issue items respectively. It should be noted that the weights of the various products varied greatly depending on the manufacturer, so the weights listed are approximately two standard deviations above the average item weight. These values were chosen so that they would adequately address the requirements ninety-five percent of the time.

Individual Issue Item	Weight per issue	Resupply items	Resupply weight
Radio and 4 Batteries	1.49	4 Batteries	0.24
Writing Materials	0.887	Paper	0.847
Playing Cards	0.125	N/A	N/A
Board Games	1.2	N/A	N/A
Bible	2.6	N/A	N/A
Hat	0.5	N/A	N/A
Sunglasses	0.6	N/A	N/A
Cigarettes and matches	0.139	Cigarettes and matches	0.139

Table 3.17 . Individual Issue Items and Their Weights and Associated Resupply Items

Community Issue Item	Weight per issue	Resupply items	Resupply weight
Baseball equipment (6 balls, 4 bats, 12 gloves, 6 bases, and a sea bag)	55.4	2 balls	2.4
Basketball equipment (6 balls & 2 baskets per set)	146.2	2 balls and a patch kit	10.6
Soccer Equipment (6 balls & 2 goals per set)	86	2 balls and a patch kit	11.2
Sewing Equipment and supplies (machine, material, & notions)	36.56 - 53.25	Material and notions	10.56 - 27.25
Craft supplies (paper, paint, crayons, markers, and paint brushes)	6.184	Craft supplies	3.092
Books	3	N/A	N/A
Barber Kit	12.5	N/A	N/A

Table 3.18. Community Issue Items and Their Weights and Associated Resupply Items

To derive the actual planning factors for individual issue items, the planner has to sum the weights of the items required. For community issue items, the weights need to be multiplied by the appropriate issue rate. The resupply planning factors are determined by dividing the resupply weight by thirty, the resupply interval in this model.

To determine a planning factor for school supplies, only the basic necessities were considered. The actual calculations required two steps. First, the rate of issue had to be determined. That is, of the individuals requiring education, who needs what items. Books, writing tools, and paper are assumed to be required by all those attending classes while chalk boards, marker boards, and easels are assumed to be required only by those doing the instruction. In an effort to control class sizes, the allocation rate of instructor supplies will be .04 per person which limits class sizes to 25 students. The exception to this rate is the corresponding writing utensils. This is because chalk and markers are believed to have a much shorter life cycle than the chalk board itself. Therefore, an allocation of .2 items per person will be established for chalk and markers. Because of the high usage rate of many of the items in an educational scenario, many of the related supplies need to be replenished. For this reason, a replenishment rate was established and will be incorporated into the resupply planning factor. Table 3.19 lists a sample of some items that may be required to provide educational services to the recipient population. In addition, the table displays the issue and replenishment rates used to develop the individual item planning factors. The actual planning factor for school supplies depends on the items selected to support the operation. For instance, if each student receives two pens, paper, and book while the instructors use chalk and a chalkboard to conduct classes the planning factor will be 4.5428 pounds per person attending classes with a .03008 pounds per person per day resupply rate.

If a resupply cycle is desired, the requirements can be quickly computed once the individual issue, community issue, and school supply requirements have been determined. If an item is likely to require a resupply cycle, the requirements were established when the item's initial issue planning factor was derived. The model provides

nine different resupply items. The items are batteries, baseballs, basketballs, and soccer balls (and patch kits), writing materials, sewing material, craft supplies, school supplies, and cigarettes. The derivation of the specific planning factors has already been discussed and they can be extracted from Tables 3.17, 3.18, and 3.19.

Item	Item Weight	Issue Rate	Surge[1]	Resupply Cycle	Sustainment[2]
	lbs.	*# per person*	*lbs.*	*days*	*lbs.*
pens	0.020	2	0.0406	30	0.00135
note pad	0.847	1	0.8473	30	0.02823
chalk board	16.000	0.04	0.6400	N/A	N/A
chalk	0.075	0.2	0.0149	30	0.00050
marker board	16.000	0.04	0.6400	N/A	N/A
marker	0.021	0.2	0.0042	30	0.0014
easel	16.000	0.04	0.6400	N/A	N/A
easel pad	5.750	0.04	0.2300	30	0.00766
books	3	1	3.0000	N/A	N/A

[1] per issue [2] per day

Table 3.19. School Supplies and Their Weights and Associated Resupply Requirements

D. CHAPTER SUMMARY

In this chapter, a definition of a planning factor was given as well as amplification of its usefulness. Then, systematically, humanitarian specific planning factors for each class of supply were derived. The importance of this chapter it two-fold. First, it allows planners to understand the make-up of the various planning factors. When a planner is preparing for an operation, a quick review of the derivation will allow the planner to determine whether additional mission specific items need to be added or whether the derived factors can adequately address the requirements. This reduces the need to unnecessarily modify a planning factor. Second, it simplifies the process of updating the planning factors. This is because each assumption and weight used is clearly defined so when new equipment is provided or more accurate weights located, the future analysts

need only update the appropriate assumption or weight. All the derived planning factors are summarized in Appendix H. The next chapter will attempt to show the derived planning factors' validity.

IV. APPLICATION AND VALIDATION

A. BACKGROUND

In the process of validating a model, in this case a logistics decision support model, one should ask "does the model offer informed judgment, decisions, or even descriptions? More precisely, does it help, when due consideration is paid to the omissions, approximations, communications effectiveness, and so on?" [Ref. 24: p. 45] Validation can be very subjective. This is because validation depends on accurate and timely operational data. If the data is incomplete, the model can not be effectively validated. Unfortunately, some organizations choose approval over validation. That is, models are declared valid because they support an organization's bureaucratic position.

This model can not be completely validated because of the lack of operational data. However, sufficient operational data has been collected on Operation Sea Signal to partially validate the model. The validation will only apply to the scenario described herein. The methodology used to validate this model will be a direct comparison of the values derived by the model against the actual consumption rate experienced during the operation. Both the derivation of the values obtained by the model and the derivation of the actual consumption rates will be explained to the reader.

B. THE SCENARIO

The data that will be used to validate a portion of this model was collected amidst Operation Sea Signal in Guantanamo Bay, Cuba in November 1994. This operation supports emigrant operations. That is, the operation is supporting the results of a man-made disaster. The operating area is Guantanamo Bay, Cuba, a tropical climate, and the operation is currently an extended duration operation. There were two populations being supported, a Cuban population and a Haitian population. The size of the populations has

varied throughout the operation. However, the demographics remained fairly constant. [Ref. 45] The breakdown of the Haitian population can be found in Table 4.1 while the breakdown of the Cuban population can be found in Table 4.2. Both populations could be classified nourished, although the Haitians are just above the undernourished category indicating they require a lower calorie intake than the Cubans. Many individuals were dehydrated when they first arrived, some were suffering from exposure, and some were injured on their journey to Guantanamo Bay. The actual number of individuals that could be classified as injured is unknown. All the emigrants were homeless and in need of assistance. Finally, Guantanamo Bay was a functioning naval base, but the base's infrastructure was not capable of supporting an additional 30,000 individuals indefinitely. Therefore, the infrastructure could be classified damaged as the existing infrastructure would require significant modification to adequately function with the enlarged population.

Category	Percentage
Children below 3	5
Children 3 - 12	8
Females over 12	20
Males over 12	67

Table 4.1. Breakdown of Haitian Demographics

Category	Percentage
Children below 3	1
Children 3 - 12	6
Females over 12	18
Males over 12	75

Table 4.2. Breakdown of Cuban Demographics

C. ANALYSIS

Since the requirements for Class III and Class VII supplies are dependent on the quantity of supplies required to support the population, they will be the last classes of supply considered. All the other classes of supply will be considered in the same order as the previous chapter. For each class of supply, the model's output will be derived first. Then when possible, the actual consumption rate will be evaluated and compared to the model's output. Any inconsistencies will be evaluated.

1. Class I - Subsistence

There are two ways that the model can derive the planning factors for Class I supplies relevant to this operation. The first method uses just one planning factor for the whole population. The primary fault of the first method is that it does not take into account the population's demographics. Using this method assumes the whole population consumes the same amount of calories, uses the same amount of water, requires the same personal items, etc. If little is know about the population to be supported, this method would suffice because the model's base planning factors do account for some variation among the recipients. However, if the demographics of the population are known, this is not an acceptable assumption. To compensate for this fault, the second method uses weighted averages. That is, the requirements for each demographic group are determined by the average requirements for each respective category. Then, the total requirements are determined by averaging the various demographic group's requirements. Throughout the validation process, examples of both methods will be used. Yet, the second methodology will be used as the primary means to validate the model's planning factors.

The first step in validating the planning factors for Class I supplies is to evaluate the nutritional status of the population. Since the opportunity to conduct weight/height comparisons never presented itself, the nutritional status of the populations will be derived from literature studies on populations found on the Internet and other automated reference

materials. The published average calorie consumption for the Cubans is 3,129 calories per person per day while the average calorie consumption published for the Haitians is 2,005 calories per person per day. [Ref. 27] This data indicates the Cuban's caloric intake is at the high end of the "normal" range while the Haitians requirements are at the lower end. There are two reasons that explain the large variation in the caloric requirements of the two populations. First, the literature indicates nearly 45 percent of the Haitian population is comprised of children under the age of 15. Since the caloric requirements of children are lower than adults, the larger percentage of children would drive the country's average caloric requirements down. Second, Cuba has a much stronger economic base than Haiti. Therefore, the Cubans have more money to spend on food. Using this background information, the caloric requirements that are used for this operation are derived using a minor modification of the recommended daily dietary allowance chart, Appendix C. That is, the moderately active category is used to determine the caloric requirements for the Cubans, but the category average is increased by ten percent to compensate for the country's high consumption rate. The Haitian's caloric requirements, on the other hand, are based on the sedentary category minus ten percent. Table 4.3 summarizes how the modification was applied using a sample population, PT, of 10,000 Cubans with the demographics described previously. Then, to apply the weighted averages method, the final column, total calories required (TC), is summed and then divided by the population total, PT. Resulting in a population average calorie consumption rate, C, of

$$C = CT/PT = 30{,}688{,}000/10{,}000 = 3068 \qquad (4.1)$$

calories per person per day. Now, placing this calorie requirement into the equation that includes milk products developed in the previous chapter which converts calories into pounds per person,

$$PP = 1.384 + .00096C, \qquad (4.2)$$

results in

$$PP = 4.33 \qquad (4.3)$$

pounds per person per day.

Category	Percent of Population	Number of Population	Average Calorie Requirement	Calorie Required Per Person	Total Calories Required
Infants	1	100	1000	1100	110000
Children under 12	6	600	1600	1760	1056000
Women (over 12)	18	1800	2500	2750	4950000
Men (over 12)	75	7500	3000	3300	24750000

Table 4.3. Application of Weighted Averages to Determine Caloric Requirements of the Cuban Population

Applying the same techniques described above to derive the Haitian requirements results in an average calorie requirement of 2054.7 calories per person per day or 3.36 pounds per person per day. Again, this quantity exceeds the published requirement because the portion of the population under the age of 15 is lower for the population being supported than for the nation as a whole. Interesting enough, both populations' planning factors for consumption exceed the 2.2 pounds per person per day requirement which is soon to be published in a document on emigrant operations. [Ref. 41]

To determine the actual subsistence consumption rate experienced during the operation, work load reports from one of the kitchens were used. Unfortunately, the data has many faults. First, the data was not in a usable unit of measure. For example, when fruit was served, it was distributed by the case. When an item is identified by the case, it required two conversions. The first conversion is from a case to servings per case; and, the second conversion is from a serving to pounds per serving. Although requisitions, menus, and the JTF's serving sizes from the operation were used to make the conversions, there is no way to verify the conversions are 100 percent accurate. The second problem with the data is it only addresses one population, the Cubans. Furthermore, only 50 percent of the Cuban population was serviced by this kitchen and the specific demographics of the group is not known. Since no suitable data was located to address the Haitians' consumption rate, it can not be validated. Although, it is known that all demographic groups were serviced by this kitchen, the data does not include any food that

is appropriate for infants (i.e. baby food). This fault will cause the consumption rate to fall short of the actual consumption rate. Also, the data only includes what was issued to the population from the kitchen. The population was periodically given juice, milk, and some candy directly from the supply department, yet none of the items are accounted for in the data. Finally, the data does not identify waste so it is assumed that everything that leaves the kitchen is served and consumed. Since the limited refrigeration does not allow for reuse of any food item, this assumption is not absurd.

After completing the necessary conversions, daily consumption rates were derived using the headcounts provided by the kitchens which include infants. The result is a average consumption rate of 4.2 pounds per person per day. Figure 4.1 visually displays the actual consumption rates experienced, the model's planning factor, the planning factor generated using reference materials. The range that is identified in the graph is one standard deviation above and below the mean of the experience consumption rate. As the graph illustrates, the planning factors generated by both the model and the reference material fall within a single standard deviation of the experience mean. Although this not a thorough validation, the results indicate that the planning factor for subsistence generated by the model can adequately address the requirements for this operation.

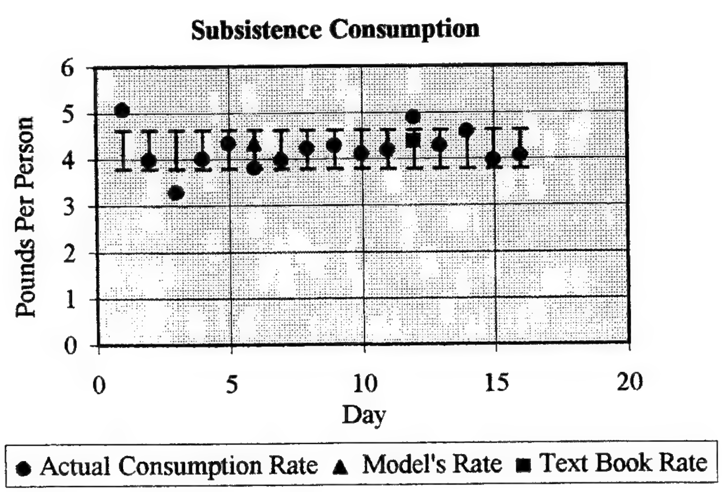


Figure 4.1. Dot Plot of Various Consumption Rates for Subsistence

There are four items that need to be considered when determining which of the model's planning factors should be used to adequately reflect the true consumption rate for water. First, the demographics of the population need to be considered. As discussed previously, demographics help determine the drinking water requirements and the hygiene requirements. It will be assumed that the demographics model the actual recipient population except that the following groups are combined: girls and women, and boys and men. This breakdown is acceptable because unless you know the weights of the children, it is not likely that you can assess the exact drinking requirements, so the larger factor will suffice. Furthermore, hygiene habits are usually taught at home and it is generally accepted that younger children tend to imitate their same sex parent with respect to hygiene habits. The new breakdown is shown for the Haitian population in Table 4.4. This chart gives a total drinking water requirement of 8,125 gallons per day. When the total water requirement is divided by the population, the new planning factor of .8125 gallons per person per day emerges. Then, the planning factor is adjusted for the tropical climate, by multiplying the .8125 requirement by the tropical climate factor of 1.3 resulting in a 1.056 gallons per person per day drinking water planning factor for the Haitians. Using the same techniques, a planning factor of 1.0985 gallons per person per day is derived for the Cubans.

Category	Percent of Population	Number of Population	Planning Factor	Drinking Water Requirement
Infants	5	500	0.4	200
Women	25	2500	0.65	1625
Men	70	7000	0.9	6300

Table 4.4. Demographic Breakdown and the Associated Drinking Water Requirements for the Haitian Population

Now, the planner needs to know how many meals and what type of meals will be served. For this operation, two hot, or prepared, meals and one MRE were served a day. Two prepared meals a day results in a planning factor of 3 gallons per person per day for food preparation while the MRE requires .25 gallons per person per day.

Finally, the planner needs to know how much water the infrastructure is capable of producing so that a showers policy can be determined. Since many factors that are not included in this model affect the infrastructure's ability to produce water, it will be assumed for the first week of operation that the bare minimum hygiene requirements will be enforced. Then, until the infrastructure is completely established, the population will be afforded one shower per week. The planning factors the model provides for the first month, or until the infrastructure is established, are found in Table 4.5. Once the infrastructure is established, more liberal showering policies can be established. Using the literature on the recipient population, personal interviews conducted with the recipient populations, and knowledge that a strong infrastructure existed several months into the operation, the following water usage rates were derived. First, the Haitians are a relatively poor culture with a low literacy rate. The country's overall literacy rate is approximately 53 percent, but the recipient population's literacy rate appears to be closer to 20 percent. Most of the illiterate are poorly educated in the basic hygiene requirements, so it is not believed that they would desire daily bathing. However, the harsh living condition combined with boredom indicates that they are likely to desire more frequent bathing than once a week, consequently, a planning factor of three showers a week will be used for approximately 75 percent, the estimated portion of poorly educated Haitians. For the portion believed to be educated, 20 percent, one shower a day will be allotted. No special allotment of water is provided for infants because the population practices communal bathing for young children. In contrast to the Haitian population, the Cuban population is nearly 94 percent literate and educated in personal hygiene. In addition, much of the population takes great pride in their appearance. For their culture, additional water for

hygiene appears to add to their quality of life. Therefore, they will be allotted two showers a day for the validation.

Use	Haitian's Planning Factors	Cuban's Planning Factors
Drinking	1.056	1.0985
Food Prep	3.25	3.25
Hygiene	1.465-3.965	1.548-4.048
Laundry	0-2.5	0-2.5
Medical	.358	.358
Waste	.613-1.112	.625-1.12
Total	6.74-12.24	6.879-12.37

Table 4.5. Water Requirements for Operation Sea Signal's Initial Phases

Since it is not believed the entire population would desire two showers a day (or perhaps one long shower), 20 percent of the population will be allotted sufficient water for one shower a day. Infants will be a allotted water equivalent to one shower or 2.5 gallons per day which is sufficient to bath an infant. The increased water consumption planning factors are summarized in Table 4.6. It should be noted that the increased hygiene planning factors for showering are not requirements. In fact, the increased levels greatly exceed the actual requirements as illustrated by the difference between Table 4.5 and Table 4.6. Affording the population additional water is strictly to increase their quality of life and thereby their morale. If the infrastructure did not exist to support these lavish levels, the requirement for one shower a week could be maintained.

Use	Haitian's Planning Factors	Cuban's Planning Factors
Drinking	1.05	1.09
Food Prep	3.25	3.25
Hygiene	10.59	32.72
Medical	0.358	0.358
Laundry	2.5	2.5
Waste	1.77	3.99
Total	19.52	43.92

Table 4.6. Water Recommendations for Operation Sea Signal's Later Phases

To validate the planning factor for water, meter readings published by Guantanamo Bay's Public Works Department were compared to the population size. The total water consumed each day was broken into what was consumed by the Haitians and what was consumed by the Cubans. Then, the consumption rates were compared with the respective population total. The analysis provides two separate consumption rates, both measured in gallons per person. The two rates were made possible because the two populations were segregated and housed in separate camps throughout the operation. After analyzing the data, a sample of 42 consecutive days, beginning on October 12, was chosen. This sample was chosen because it was the only sample of the data where the available data relating to population demographics and camp organization (including which populations were housed in which camps) was also complete. There are a few flaws with the data. First, the data is not broken down by specific use of the water; therefore, only one daily consumption rate which includes all the uses could be attained for each population. Secondly, it does not cover the entire operation so only the sustainment rate can be validated. A summary of the sample data can be found in Table J.1 in Appendix J.

Once the data sample was converted into daily consumption rates, the daily consumption rates were averaged and basic data analysis techniques were applied to the sample. The results of the analysis show that the average water consumption rate experienced during the sample period of the operation was 18.71 gallons per person per day for the Haitians with a standard deviation of 6.31. The average consumption rate experienced during the operation was compared with the water consumption planning factor generated by the model for Sea Signal's later phases, 19.52, since the sample data is dated almost three months into the operation. A dot plot of the daily consumption rates experienced during the operation as well as the rate predicted by the model can be found in Figure 4.2 to visually display the results. As the figure illustrates, the model's planning factor of 19.52 can certainly satisfy the aggregate water requirements as it only exceeds the actual consumption rate by .81 gallons per person per day which is well within a single

standard deviation of the mean. It is important to point out the possible causes of the model's slight overestimate. First, the initial assumptions may have been incorrect. That is, perhaps only 10 or 15%, rather than 20% of the population truly want a shower a day. Or, since the water required for a shower developed by the model already includes allowances for error, perhaps the waste factor is slightly high.

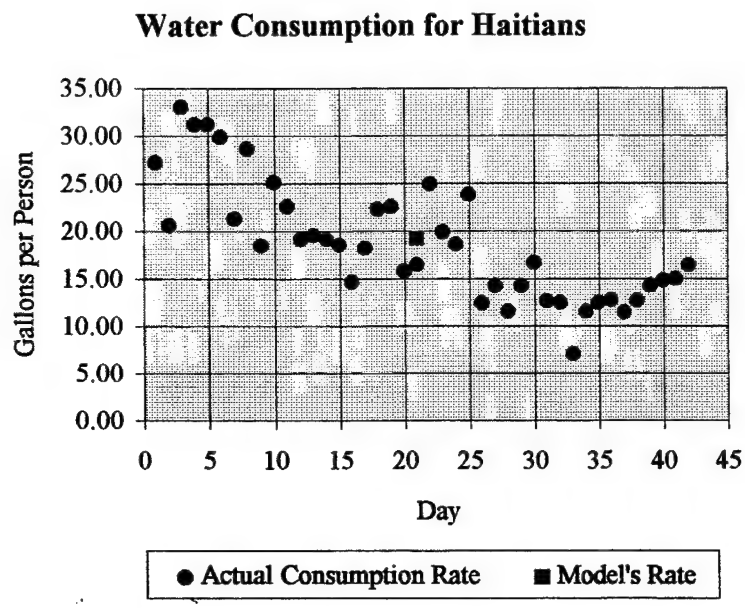


Figure 4.2. Dot Plot of Various Consumption Rates for Water for the Haitians

With regard to the Cubans, the analysis indicates an average experienced consumption rate of 44.17 with a standard deviation of 21.81 as summarized in Table J.2 in Appendix J. The experienced consumption rate is .25 gallons per person above the model's planning factor of 43.92 which is substantially less than a single standard deviation. Again, the error is believed to be the result of imprecise estimates regarding the percentage of the population that would like two showers a day. If the percentage is varied slightly, the error is quickly reduced to less than one percent. However, rounding percentages to common intervals (like five percent) is standard practice in logistics planning. The resultant planning factor can still adequately address the aggregate requirements as illustrated by Figure 4.3.

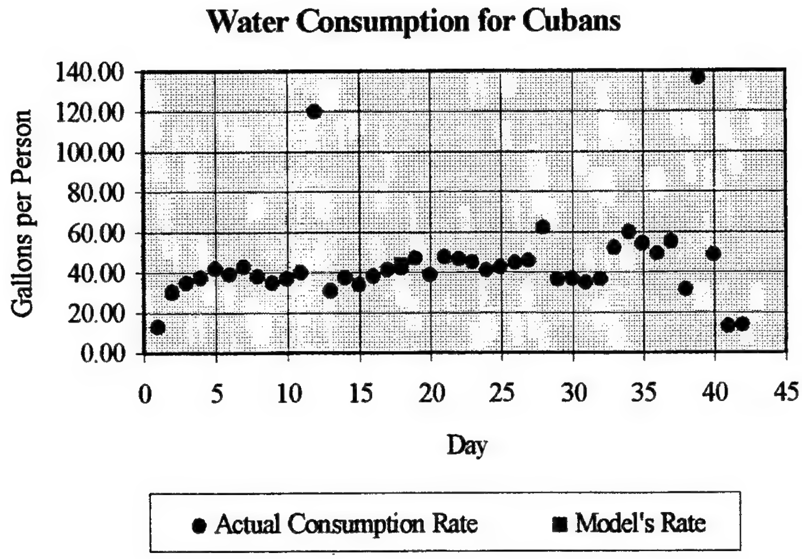


Figure 4.3. Dot Plot of Various Consumption Rates for Water for the Cubans

To determine the planning factor for utensils, the planner needs to know how many prepared meals will be served and what type of menu items will be served. As stated before, two prepared meals will be served. The remaining meal, a MRE, already has utensils supplied so it does not need to be considered. After reviewing the menus, it was determined that for the breakfast a plate, napkin, cup, knife, and spoon would be required. For the evening meal, a plate, napkin, and a fork appear to be sufficient. Adding the planning factors for the various utensils required for each meal, see Table H.7 in Appendix H, results in a planning factor of .0859 pounds per person for the morning meal and a planning factor of .0595 pounds per person for the evening meal. The end result is a planning factor of .1454 pounds per person per day for utensils with one exception. Children under 3 do not need knives because it is assumed their parents will help them, so .0167 pounds is deducted from the adult planning factor resulting in .1287 pounds per person per day for this demographic group. Then, using weighted averages results in a planning factor of .14 pounds per person per day for the Haitians and .145 pounds per person for the Cubans.

The data used to validate the planning factor for utensils is the same data used to validate the planning factors for subsistence. Therefore, the same faults as previously discussed are present. The results of the analysis show (Table I.3 in Appendix I) the mean daily consumption rate for utensils is .1294 with a standard deviation of .027. Although the model's planning factor is well within one standard deviation of the experienced mean, it exceeded the actual mean by almost ten percent. After reviewing the data, it was found that no napkins or knives were included in the data and cups were only issued sporadically; however, all these items were requisitioned. The question remains as to whether or not these utensils were issued. The analysis was conducted again omitting knives, napkins, and providing cups only with the morning meal. The resulting daily planning factor of .118 pounds per person was computed. Again, close to a ten percent error was experienced. This is believed to be due to the fact that excessive quantities were issued and not accounted for after the meal (i.e. waste, excess, etc.). Figure 4.4 illustrates the daily consumption rates experience during the operation, the model's planning factor, and the modified planning factor developed after reviewing the data. Although the model's planning factor adequately addresses the quantity required, the validity of the planning factor's make-up has a great deal to do with whether or not other utensils were issued to population by other sources and whether or not excess stocks were re-issued.

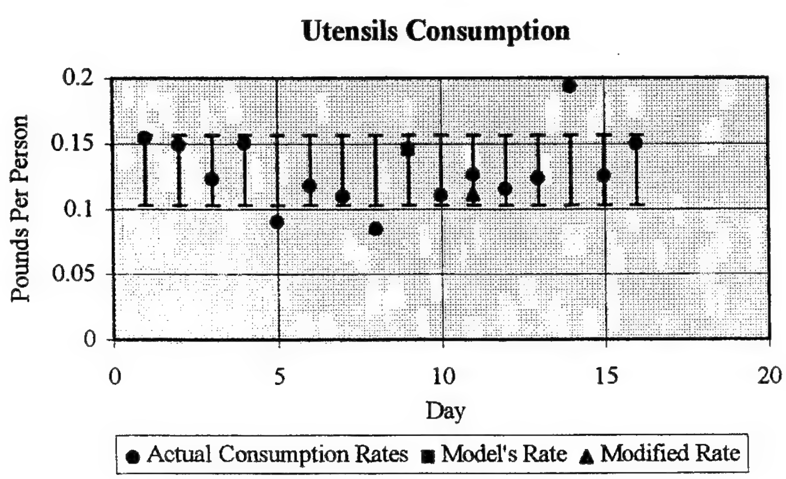


Figure 4.4. Dot Plot of Various Consumption Rates for Utensils

2. Class II - Personal Supplies

The main factors that need to be considered when deriving the planning factor for Class II supplies are the climate, the duration, and whether or not the population needs assistance and/or is homeless. In this case, the emigrants were in a tropical climate, the duration was initially unknown, and the entire population needed to be housed and clothed. When considering the duration of previous operations of a similar nature, like the Mariel boat lift, assuming the operation would continue indefinitely would not be out of the question.

With the factors affecting the requirements determined, the next step is to determine what should be supplied. First, the clothing items will be considered. The duration of the operation suggests that the Services would want the longest possible wear out of the items distributed to reduce the need to resupply; therefore, the basic clothing requirement, shirts, shorts, underwear, socks, and flip-flops will be issued in units of five. Sneakers will be issued one pair at a time. Table 4.7 displays the planning factors for the various item for both populations. The planning factors are presented in the traditional per person per day form as well as the pounds per person per issue form used to compute the initial surge requirements. The final column of the table presents the total per person requirement.

	Planning Factors			
	Cuban Population		Haitian Population	
Item	per day	per issue	per day	per issue
shirts	0.0390	2.330	0.037	2.220
shorts	0.040	2.400	0.038	2.285
underwear	0.013	0.805	0.013	0.797
socks	0.014	0.835	0.013	0.789
sneakers	0.021	1.915	0.021	1.86
flip-flops	0.031	1.830	0.029	1.720
Total	0.158	10.115	0.151	9.671

Table 4.7. Logistics Planning Factors for Clothing Predicted for Operation Sea Signal.

Again, due to the duration of the operation, it is believe all the personal equipment items will be issued. In addition, it is believed an additional sheet, pillowcase, towel, and washcloth would be beneficial in decreasing the resupply cycle required for these products. Table 4.8 summarizes the planning factors, in both a pounds per person per day quantity and a pounds per person per issue quantity, indicated by the model.

	Planning Factors			
	Cuban Population		Haitian Population	
Item	per issue	per day	per issue	per day
cot	10	0.0274	10	0.0274
blanket	1.985	0.0054	1.925	0.0053
sheets	1.99	0.0111	1.95	0.0108
pillow	0.99	0.0027	0.95	0.0026
pillowcase	0.396	0.0022	0.38	0.0021
bucket	0.812	0.0022	0.86	0.0024
towel	0.998	0.0055	0.99	0.0055
washcloth	0.12475	0.0007	0.12375	0.0007
rain poncho	0.594	0.0033	0.57	0.0032
Total	17.88975	0.0606	17.74875	0.0599

Table 4.8. Planning Factors for Personal Equipment Predicted for Operation Sea Signal

As both tents and housekeeping supplies were required, their planning factors need to be calculated. Every person in the population requires shelter. Therefore, ample GP medium tents to house the population need to be requisitioned. Since Cuba is in a tropical climate, the liners will also be requisitioned to counter the effects of possible rain showers. The purchase of a tent with a liner amounts to approximately 45.42 pounds per person that needs to be included in the initial surge of supplies. As for housing supplies, to complete one load of laundry a week .5 pounds of soap is required a week which equates to .0714 pounds per person per day. In addition, three trash bags will be allotted a week or 1 trash bag every two days which amounts to .027 pounds per person per day.

There are many reasons why the actual consumption rate of this class of supply can not be reviewed. Class II items were issued on board the ships as the emigrants were taken aboard, as the emigrants were being entered into the Deployable Mass Population Identification and Tracking System, and within the camps in which they were assigned to live. Furthermore, very little evidence was found indicating that tracking of these items occurred. It is believed that the huge influx of emigrants is the reason little tracking was found. In addition, civilian organizations augmented the Class II requirements, but no tracking of the items occurred. There was no way to identify if all the items were distributed to the recipient population or not. In fact, there were many instances when entire shipments had to be disposed of because they were exposed to the weather and yet no written documentation was located.

Each person was supposed to receive a sundry pack that includes Class II and Class VI items when entering a camp. The Class II items include: a towel, a washcloth, a gallon bucket, a soap dish, a toothbrush holder, a laundry bag, two sheets, a blanket, a pillow, a pillowcase, two shirts, two pairs of shorts, and a pair of flip-flops. Upon interviewing the emigrants, it was found that they were also issued undergarments and additional shirts. There was a great deal of diversity in the clothing found in the various camps indicating a great deal of contributions from the civilian organizations. The only requests that were solicited for the populations were for shoes, socks, and size specific items.

The only conclusion that could be drawn is that items provided by this model are similar to those actually used in Operation Sea Signal. The noted exceptions are that the model does not provide a soap dish, a toothbrush holder, and a laundry bag. None of these items are believed to be absolute necessities. For instance, the recipient population does not have enough clothing to warrant a laundry bag. Furthermore, the bucket or washbasin can be used for storing the toothbrush and soap. However, including these items is certainly not unreasonable. The validity of the actual planning factor will remain unknown until actual data can be obtained.

3. Class VI - Hygiene Items

To derive the planning factor for Class VI that is applicable to operation Sea Signal, only two factors will be considered. First, the duration of the operation has already been established as indefinite so it will be assumed the JTF will be tasked to provide the population with the necessary products to maintain their personal hygiene. As stated before, each demographic group requires different hygiene products so the population make-up should also be reviewed when determining the hygiene requirements. Using weighted averages on the requirements for each demographic group results in a planning factor of .1605 pounds per person per day for the Cuban population and .1572 pounds per person per day for the Haitian population. To establish the initial surge requirements, these planning factors will be multiplied by 30, a resupply cycle that can be used. The resulting planning factors are 4.8135 pounds per person per issue (per month) for the Cubans and 4.7162 pounds per person for the Haitians.

For many of the same reasons discussed when attempting to verify the Class II planning factors, the Class VI planning factors developed by the model could not be validated. Again, all that can be said is that the items that were provided to the population are similar to the ones contained in this model. In addition, Operation Sea Signal planners also provided the victim population with body lotion. Since lotion is not considered a necessity it is not included in the model but, as stated previously, the model is developed to give the planners a logical place to begin logistics planning for humanitarian operations and it is at the logisticians' and Commanders' discretion to augment the basics requirements as they deem necessary.

4. Class VIII - Medical Supplies

To derive the medical requirements for this operation a few questions should be asked. First, what level of medical services will be provided to the population? Considering the general isolation of the recipient population from civilian medical facilities, it is assumed the Services will be tasked to render all medical care to the victim

population. The second question that needs to be asked is; What is the general health status of the recipient population? Although a small portion of the population was injured or suffering from exposure when they were received in Cuba, the majority of the victims were in good health. The general good health of the recipient population, indicates that the maximum of .02 beds per person would be excessive for this operation. Unfortunately, the exact percentage of the population that was injured is unknown; therefore it will be assumed that less than 20% of the population secured in Cuba received injuries during their journey. This assumption would establish a bed allotment rate of .005 beds per person. Maintaining the same basic quantity of supplies per hospital bed of 70.566 pounds, the quantity of medical supplies required per person would be .3528 pounds per day. For the infants being supported, the planning factor would be increased to 1.1028 pounds per infant per day. These planning factors would apply to both populations being supported by Operation Sea Signal. Applying the weighted average technique described previously results in a population specific planning factor of .3603 pounds per person per day for the Cuban population and .3857 pounds per person per day for the Haitian population.

To support the medical requirements for the operation, two Air Transportable Hospitals (ATHs) were deployed. At the time the two hospitals were deployed, the population being supported was approaching 30,000. Each hospital contains 50 beds which provided a total of 100 hospital beds that were dedicated to the support of the emigrants. [Ref. 46] This equates to a hospital bed allocation rate of approximately .003 or 3 beds for every 1000 people. Although this figure is lower than the figure predicted by the model, it is important to note that there is a fully functional hospital on the base that was also assisting with medical services. The exact extent of the base hospital's participation is unknown; however, only 50 additional beds would have to be available to meet the .005 beds per person allocation rate identified by the model.

In an attempt to determine the actual consumption of medical supplies, the initial load lists for the ATHs were obtained. The initial load lists are supposed to contain

enough supplies to operate for thirty days. [Ref. 43] Therefore, the total supplies shipped should be divided by 150 (50 beds x 30 days of supply) to obtain a per bed requirement for medical supplies. The problem that was encountered is that the cargo included in the deployment shipments varied throughout the course of the deployment. That is, the predicted supplies in each ATH cargo increment differed from the line item description which varied from the supplies that were declared with the customs agents. Since the listing of the customs declarations is the last step until the deployment was complete these are the figures that were used. The customs forms identify 139,460 pounds of medical supplies which equates to 92.97 pounds of medical supplies per hospital bed. Under the assumption that the hospital does not augment the ATHs (the worst case scenario), the ATHs provide .2789 pounds per person per day. Any assistance the ATHs receive from the hospital will increase this planning factor. Unfortunately, the extent to which the hospital augmented the ATHs is unknown. All that can be said regarding the validity of the planning factors derived by the model is that, although excessive, they appear to address the needs of the recipient population. They resultant excess in supplies amount to approximately .1068 pounds per person per day for the Haitians and .0817 pounds per person for the Cubans. Fortunately, resupply lines for medical supplies are determined by actual usage rates, so it is believed that excess can be addressed expediently.

5. Class X - Humanitarian Specific Items

Since Operation Sea Signal is an extended duration operation and the population is not free to move about, there is an obvious need for Class X items. The requirements for the Cuban population will be established first; then the Haitian requirements will be computed. The first step in determining the requirements is to decide what items will be distributed. Because of the high probability of restlessness within the Cuban population, it is assumed all possible Class X items will be considered.

Primarily because of the excessive duration of the operation, the individual issue items that will be allotted are a radio, writing materials, playing cards, board games, a Bible, and cigarettes. Again, cigarettes will be issued to the portion of the population that

equates to the size of the male population, Bibles will only be issued to the adults, and the other items will be issued to all but the infants in the population. To compute the planning factor, the total weight required for each of the items is calculated. For example, for a population size of 10,000 with demographics similar to the Cuban population found in Guantanamo Bay, 1042.5 pounds of cigarettes are required. Continuing these calculations results in the following weights: 24,180 pounds of Bibles, 11,880 pounds of board games, 8781.3 pounds of writing materials, 1237.5 pounds of playing cards, and 14,751 pounds of radios. When these six weights are summed together and divided by the population size, the planning factor associated with individual issue items results. This planning factor is 6.1872 pounds per person. The corresponding resupply requirement is .0393 pounds per person per day.

To calculate the planning factor for community issue items, the weights of each community issue item are summed then multiplied by the allocation rate. The total weight of the supplies being considered is 345.8440 pounds. Multiplying this figure by the allocation rate of .004, one per every 250 personnel supported, results in a 1.3834 pounds per person planning factor. Using the same calculations, the resupply rate of .1514 pounds is derived. By dividing by the resupply cycle of thirty days, the sustainment rate of .0050 pounds per person per day results.

Approximately fifteen percent of the population is between the ages of six and eighteen, so it is assumed that school supplies will be considered for fifteen percent of the population. The specific items that will be considered are books, writing utensils, paper, chalk boards, and chalk. Each item's planning factor can be extracted from Table H.20 in Appendix H and summed. This equates to a surge requirement of 4.5428 pounds per student and a sustainment quantity of .03008 pounds per student. These planning factors can then be converted to a pounds per person planning factor by determining the total weight requirement of the school supplies and then dividing the weight by the population size. Using the arbitrary population size of 10,000, there are 1500 anticipated students. These students require a total of 6814.2 pounds of school supplies. Dividing by the

population size of 10,000 results in a planning factor of .6814 pounds per person per day which can be applied to the whole population. Similarly, the sustainment requirement for school supplies would be .0045 pound per person per day.

The total resupply requirement can be computed by summing the three resupply quantities previous discussed. The total resupply requirement that is calculated for Class X supplies is .04880 pounds per person per day. Finally, to determine the total surge planning factor for Class X items, all the surge quantities are totaled for a 8.2520 pounds per person surge requirement.

Using the same calculations, the Class X planning factors for the Haitian population were derived. The individual items required amount to 5.8720 pounds per person with a sustainment requirement of .0375 pounds per person per day. It is assumed that the community issue items will be distributed at a lower rate then the one used to determine the requirements for the Cuban population. This assumption is based on the educational level of the Haitians. Due to the lower educational level, it is believed less outside stimulation is required to reduce the probability of the population experiencing boredom. So, an allocation rate of one item per 500 supported personnel will be used which amounts to a .6917 pounds per person surge requirement and a .0025 pounds per person per day sustainment requirement. Approximately twenty percent of the Haitian population is school age. Allotting the same school supplies to the Haitians as was allotted to the Cubans results in a .9085 pounds per person planning factor for the surge and .0060 pounds per person per day for sustainment. When all these planning factors are combined, the Class X planning factors for the Haitian population are completed. The planning factors are 7.4818 pounds per person for surge and .0461 pounds per person per day for sustainment.

It was very difficult to identify any correlation between the model's planning factors and the actual consumption rates for Class X items for three reasons. First, although the data contained all the items and quantities that were purchased, it did not provide the weights of the items. Secondly, Operation Sea Signal did not establish a

resupply cycle for Class X items, so the surge rate that was experienced greatly exceeds the surge rate identified by the model. For example, the number of soccer balls that would be purchased using the six per 250 supported Cubans allocation rate described previously would amount to 566.4 soccer balls. During the operation, 750 soccer balls were purchased for the Cubans. Adding the equivalent of a single month's sustainment rate of soccer balls, 188.8 balls, fills the gap nicely; however, each successive month's replenishment rate will rapidly exceed the amount actually purchased. Since the actual intentions of the Commander are unknown, there is no way to identify a relationship between the actual requirements and the model's output.

Finally, although some tracking of the supplies occurred in the theater, not all the purchased items could be traced to the hands of the intended population. Moreover, there is no way to tell whether the items were actually used or if shortfalls of certain items occurred. For example, 210 sewing machines were actually ordered to support the Cuban population, but after completing tours of the Cuban camps only 10 sewing machines were actually found in operation.

The items that were actually purchased also include many toys and musical instruments which were not built into this model. The uniqueness of this operation appears to be the driving force for such items. Although the need for these items is not believed to be the norm, operations specific items that are required can be provided by this model if the planner has the applicable shipping weights. No further analysis was conducted since the shipping weights of the items were not available.

6. Class IV - Construction Materials

During Operation Sea Signal, the entire population was completely dependent on the Services. For the analysis, a Cuban population of 23,600 people and a Haitian population of 11,700 people will be used. Since the infrastructure was unable to support the size of the population, the Services had to build housing, latrines, and kitchens. Medical facilities were also required, but the Services chose to use deployable assets. Therefore, no construction materials for medical facilities will be considered.

The first area that will be considered is housing. Because of the large quantity of excess tents located while touring the operational area, it will be assumed that tent maintenance will be conducted. So, an allotment of 545 pounds, the weight of a GP Medium tent, will be provided for every 600 people. This amounts to approximately .9083 pounds per person. Since the operation was conducted in a tropical climate, no considerations for heating equipment are required. Finally, considerations for barrier material are required because the population was being housed on a United States military installation and the supported personnel are not U.S. citizens. Including the 56 pounds per person allotment for barrier materials the total per person planning factor for housing is 56.9083. No replenishment cycle will be considered.

The Services were also tasked to provide the emigrants restrooms, bathing facilities, and kitchen services. Using the allocation rates described in the previous chapter, 1180 port-o-lets and 48 shower stalls are required to support the Cuban population. To support the Haitians, only 585 port-o-lets and 24 shower stalls are required. The calculation of the associated planning factor is simply a matter of multiplying the required number of port-o-lets by the weight of a port-o-let (including 30 days of chemicals) and dividing by the size of the supported population. Similarly, the required number of shower stalls is multiplied by the weight of a shower stall and divided by the size of the supported population. Then, the two values are added together. In the case of the Cuban population, the planning factor for latrines is 13.5571 pounds per person. That is, 10.50625 pounds per person is required for toilet facilities and 3.0508 pounds per person for showers. The latrine planning factor for the Haitians is 13.5832 pounds per person. Because the chemicals in the port-o-lets must be replaced on a weekly basis, a resupply rate of .0035 pounds per person per day will also be established. Finally, kitchen services require an allotment of six pounds per person.

Using the gross planning factors identified in Chapter 3, the total square footage required for storage, 86626.2 square feet, can be obtained by summing the two square footage columns in Table 4.9. Then, by dividing the total required storage space by the

storage space available in a supply tent, 358 square feet, the total number of supply tents needed can be calculated. Upon completion of the calculation, a requirement for 294 supply tents is derived. One hundred and ninety seven of the supply tents are required to support the Cuban population and 97 supply tents are to support the Haitian population. The total weight of all the supply tents can be calculated by multiplying the required number of supply tents by the weight of a supply tent, 402 pounds. This equates to 118,188 pounds of which 79,194 pounds are to support the Cubans and 38,994 pounds are to support the Haitians. Finally, the per person planning factor can be calculated by dividing the total weight of the supply tents required by the size of the population being supported. Regardless of the population being support, the planning factor is 3.35 pounds per person.

	Square Footage Required	
Class of Supply	Cubans	Haitians
Class I	24992.4	12390.3
Class II	11965.2	5931.9
Class VI	17558.4	8704.8
Class VIII	3823.2	1895.4
Class X	11965.2	5931.9

Table 4.9. Square Footage Requirements for Storage

To determine the actual usage of construction materials, the only data that was available was requisition forms. Again, the data is quite complete if quantities and items are the only consideration. However, to derive a consumption rate or a planning factor the weights of the items are required as well as an indication of true usage in the theater. Approximately eight-five percent of the items are not available through the government stock system and most commercial hardware companies were not able to assist in converting the quantities to pounds. Therefore, quantifying the actual requirements was not possible.

The model attempts to incorporate the major construction requirements. The major items that were actually used in the operation include barrier materials, galley

equipment, port-o-lets, and shower materials. The model contains all these items. However, the degree of accuracy in the derived planning factors is unknown. Upon further validation, any inconsistencies in the derived planning factors can be corrected.

7. Class VIII - Support Equipment and Class III - POL

Once all the material requirements have been determined, the planning factor for support equipment can be calculated. Calculating the number of vehicles required to handle the surge should provide the maximum number of vehicles required at any one time during the operation. Up to this point, 3,699.0286 tons of supplies have been identified to support the Cuban population and 1660.0537 short tons of supplies have been identified to support the Haitian population. These values include thirty days of supply. The actual number of vehicles in the theater is heavily dependent on the operating environment. That is, how far do the vehicles have to travel, how fast will they travel, how long will the vehicles be loading and unloading, and how long will the vehicles operate? It will be assumed that the average one-way distance traveled will be 20 miles, the average speed is 30 miles per hour, 1.5 hours will be allotted to unload and load the vehicles for each trip, and the average day of vehicle operations is ten hours. From these assumptions, the turnaround time of the vehicles can be calculated. Using the formula to calculate the turn-around time discussed in the previous chapter, a turnaround time of 2.83 can be calculated. In other words, each trip a vehicle makes takes 2.83 hours.

The number of vehicles required to transport cargo and personnel are both calculated using the same formula. The requirements can be calculated by multiplying the quantity of cargo to be transported by the turnaround time and then dividing by the capacity of the vehicle to move cargo and the length of the operational day. The capacity of the vehicles was described in the previous chapter and the total requirement will be increased by 20 percent to accommodate a maintenance schedule. Namely, if five ton cargo trucks are used, six short tons of supplies or 20 passengers can be moved. After completing the calculations, a requirement for 210 vehicles to transport cargo is identified for the Cuban population and 95 vehicles for the Haitian population. Assuming only five

percent of the population requires transportation at one time, 21 vehicles are required to transport Cuban personnel and 10 vehicles to transport the Haitians.

Forklift requirements are very easy to calculate. The total surge quantity of cargo just needs to be divided by 120, the average number of pallets a forklift can move in a day. For the Cuban population, 31 forklifts are required. However, to accommodate a maintenance schedule, the required number of forklifts will be increased by 20 percent which increases the forklift requirements to 37. Similarly, 17 forklifts are required to support the Haitian population.

Generator requirements for this model depend on the condition of the infrastructure and the size of the population being supported. In this case, the infrastructure is damaged and there are 23,600 Cubans and 11,700 Haitians. The current condition of the infrastructure establishes the allocation rate at .0011 generators per person. However, this figure will have to be increased by 20 percent to accommodate the readiness rate of 80 percent. Therefore, each of the population sizes need to be multiplied by .00132 to determine the number of generators required. The results of the calculations is a requirement for 32 generators to support the Cuban population and 16 generators for the Haitian population.

The number of refrigerated containers required depends on the condition of the infrastructure and the number of the meals served each day. Again, the infrastructure is considered damaged so the model calls for ten percent of the weight of the two prepared meals to be refrigerated. Assuming each meal weighs exactly the same, the two prepared meals weigh 2.8867 pounds per person for the Cubans and 2.24 pounds per person for the Haitians. Ten percent of these quantities equates to .2887 pounds per person for the Cuban population and .224 pounds per person for the Haitian population. Determining the total quantity of supplies requiring refrigeration is simply a matter of multiplying the pounds per person quantity by the size of the respective population. After completing the calculations, 6812.5333 pounds require refrigeration to support the Cuban population and 2620.8 pounds require refrigeration to support the Haitian population. However, it will be

assumed that 30 days of supply will be maintained so these figures need to be multiplied by 30. Consequently, the total quantity of supplies that require refrigeration is 204,376 pounds for the Cuban population and 78,623 pounds for the Haitians. The only calculation that remains to determine the number of refrigerated containers needed is to divide the total quantity of supplies requiring refrigeration by the cargo capacity of a refrigerated container. A refrigerated container has a 41,300 pound cargo capacity. However, it will be assumed only 80 percent of the cargo space will be used since the containers are being used as kitchen refrigerators and the cooks must be able to maneuver around in the container. Therefore, eight containers are required to support the refrigeration requirements of the Cuban population and three containers are required to support the Haitian population.

The requirements for container handlers are derived directly from the number of containers in the theater. That is, one container handler is allocated for every fifty containers in the theater. Based on the number of refrigerated containers required, one container handler is required to support both populations. However, it should be noted that a second handler should be considered to allow time to conduct preventive maintenance.

To determine the number of water purification units, ROWPUs, and water trucks required, the total quantity of water that is required on a daily basis must be computed. For the Cubans, 1,035,376.8 gallons of water are required each day while only 229,388.44 gallons for the Haitians. It will assumed that the infrastructure is capable of producing 50 percent of the water so, the ROWPUs only need to produce 517,688.4 gallons for the Cubans and 114,694.22 gallons for the Haitians. The ROWPUs included in this model produce approximately 3000 gallons per hour. Assuming the ROWPUs operate a maximum of twenty hours a day, each ROWPU can produce 60,000 gallons. Therefore, using equation 3.14 on page 75, to produce 517,688 gallons of water and to allow for a twenty percent down-time, 11 ROWPUs would be required to support the Cubans. Similarly, three ROWPUs would be required to support the Haitian population. It will

also be assumed that only ten percent of the total daily water requirements will have to be delivered. This is because the water produced by the ROWPUs can be pumped directly into the camps so, there is no need to transport the water to the camps. This means only 103,537.6 gallons of water need to be transported each day to support the Cubans and 22,938.844 gallons need to be transported to support the Haitians. Assuming 1000 gallon capacity water trucks are used to transport the water, the same turn-around time is used, and the requirements still need to be increased by 20 percent to address maintenance schedules, 36 water trucks are required to move ample water to support the Cuban population and 8 water trucks are required to move ample water to support the Haitian population.

The requirements for sanitation and garbage trucks are based on a location policy rather than the traditional policy previously described. This is primary due to the nature of the services these vehicles provide. To maintain the operators morale, it will be assumed that these vehicles will only be required to make one transit per day. That is, the vehicle will fill to capacity, return, and unload only once. To determine the requirements for sanitation vehicles, the number of port-o-lets being used must be known. Using the combined population total of 35,300 and the port-o-let allocation rate of .05, 1765 port-o-lets are required to support the two populations. Using a sanitation vehicle with a 1000 gallon capacity, 200 port-o-lets can be serviced by a single truck. So, a total of nine operating sanitation trucks are required. Allowing for 20 percent down-time increases the requirement to 11 trucks. However, if the populations were supported separately, 12 sanitation trucks would be required, eight to support the Cubans and four to support the Haitians. In a similar augment, two garbage trucks are required to support the combined populations as one truck is required to support every 25,000 people. Separately, two garbage trucks would be required to support the Cubans and one to support the Haitians.

The requirements for wreckers are based on the number of vehicles in the theater. This model allocates wreckers at a rate of one per 100 vehicles in the operating area. With 323 wheeled vehicles identified to support the Cuban population and 140 wheeled vehicles

identified to support the Haitian population, four wreckers are required to support the Cuban population and two are required to support the Haitian population.

Before the actual planning factor for support equipment can be determined, the fuel requirements must be established as the fuel requirements will increase the quantity of support equipment required to support the operation. The first fuel consideration is packaged POL. The planning factor that was developed for packaged POL is .295 pounds per person. Adding the 104.43 short tons associated with a thirty day supply of packaged POL to support the Cuban population increases the requirements for forklifts and cargo trucks. Using the same calculation previously discussed, two additional forklifts and six additional trucks are required to support the Cuban population. Similarly, to handle the addition 51.7725 short tons of supplies generated by packaged POL requirements to support the Haitians population requires one additional forklift and three additional cargo trucks.

The only other calculation that needs to be completed before the actual POL planning factor can be calculated is determining the number of fuel consuming items that are not considered support equipment, namely, heaters and galley equipment. As stated before, heaters are not a consideration for this operation. Galley equipment, on the other hand, is a consideration. It was assumed that the all fuel consuming galley equipment will be allocated such that one piece of equipment can service 1000 people. Therefore, 24 pieces of fuel consuming galley equipment are required to support the Cuban population and 12 pieces are required to support the Haitian population.

To compute the quantity of fuel used each day, each piece of equipment has to be multiplied by its fuel consumption rate and the number of hours the equipment will operate or the number of miles the equipment will travel in a day. Given that the vehicles will operate ten hours a day, each vehicle can make approximately 3.5 trips a day or travel 141.1765 miles a day. The exceptions are sanitation and garbage trucks. The requirements for these trucks were based on allocation policies (i.e., one per 200 port-o-lets) and are only expected to make one round trip journey each day which amounts to 40

miles per day. The equipment with an hourly consumption rate will have one of two different operational rates. That is, it will be assumed that equipment that requires a full-time operator, like a forklift, will have a ten hour work day while equipment that does not require a full-time operator, like a generator, will operate for twenty hours a day. Again, there are two expections. Refrigerated containers are expected to operate around the clock and kitchens are excepted to operate 16 hours a day. Table 4.10 summarizes all the fuel consuming equipment required to support each of the populations as well as the total fuel required to operate the equipment for a day.

Item	Quantity Required to Support Cubans	Total Fuel Requirements	Quantity Required to Support Haitians	Total Fuel Requirements
5-Ton Cargo Truck	237	4158.93	108	1895.21
4000 Lb. Rough Terrain Forklift	39	1950.00	18	900.00
Rough Terrain Container Handler	1	85.00	1	85.00
1000 Gal. Water Transport	36	631.74	8	140.39
Sanitation Truck	8	39.78	4	19.89
Garbage Truck	2	49.68	1	24.84
5 - Ton Wrecker	4	126.32	2	63.16
ROWPU	11	2068.00	3	564.00
Refrigerated Container	8	209.28	3	78.48
Generator	32	3840.00	16	1920.00
Kitchen Equipment	24	241.92	12	120.96

Table 4.10. Vehicles Identified to Support Operation Sea Signal and their Associated Daily Fuel Consumption Rates

Interestingly enough, knowing the quantity of fuel required in the theater generates additional equipment and fuel requirements because the fuel must be delivered as well. The requirements for fuel tankers are determined by the quantity of fuel in the theater that must be transported. It will be assumed that all the fuel will require transportation and that separate vehicles are required to transport diesel fuel and motor fuel. As Table 4.10

illustrates 13,355.94 gallons of fuel are required to support the Cubans and 5,789.57 gallons for the Haitian population. These requirements break down to 12,311.21 gallons of diesel fuel and 1,044.73 gallons of motor fuel to support the Cubans and 5,442.69 gallons of diesel fuel and 346.88 gallons of motor fuel to support the Haitian population. The capacity of the fuel tankers included in this model is 1200 gallons and the turnaround time will remain 2.83 hours. Therefore, five tankers are required to support the Cuban population and two tankers are required to support the Haitian population. Now, the additional tankers need fuel. The fuel required to operate the tankers required to support the Cuban population is 65.79 gallons while the fuel required to operate the tankers to support the Haitian population is 26.32 gallons. The question remains as to whether additional tankers are required to move the fuel which operates the tankers.

Each tanker has the capacity of moving 4240.28 gallons of fuel each day and a tanker operates on motor fuel. Therefore, if the motor fuel required to operate the tankers and the motor fuel required to operate the other motor fuel driven equipment do not exceed the capacity of the number of tankers required to deliver motor fuel, then no additional tankers are required. Otherwise, the number of additional tankers required will have to be calculated and the whole process begins again. In both case, the additional fuel required to operate the tankers does not exceed the current capacity of the tankers, so no additional equipment is required.

Now that the total fuel requirements are determined, the planning factor for POL can be determined. The only computation that remains is to divide the total fuel required, 13421.73 gallons to support the Cuban population and 5815.89 gallons to support the Haitian population, by the size of the respective populations. This results in a POL planning factor of .5687 gallons per person to support the Cuban population and .4971 gallons per person to support the Haitian population.

Finally, the computations required to derive the planning factor for support equipment can begin again. Table 4.11 displays all the equipment that has been identified

and the total weight of the equipment in question. The only calculation that remains is to divide the total weight by the size of the population.

Item	Quantity Required to Support Cubans	Total Fuel Requirements	Quantity Required to Support Haitians	Total Fuel Requirements
5-Ton Cargo Truck	237	5214000	108	2376000
4000 Lb. Rough Terrain Forklift	39	1056900	18	487800
Rough Terrain Container Handler	1	105120	1	105120
1000 Gal. Water Transport	36	522000	8	116000
1200 Gal. Fuel Transport	5	75000	3	45000
Sanitation Truck	8	116000	4	58000
Garbage Truck	2	72000	1	36000
5 - Ton Wrecker	4	137600	2	68800
ROWPU	11	417560	3	113880
Refrigerated Container	8	32000	3	12000
Generator	32	241280	16	120640

Table 4.11. Vehicles Identified to Support Operation Sea Signal and their Associated Weights

The only data that was obtained for Guantanamo Bay regarding fuel consumption was the average monthly consumption rate. The Fuels Division from Guantanamo Bay, Cuba was able to provide the average monthly consumption rate of 41,382 gallons for the base's service stations. Unfortunately, this figure is only about a third of the value predicted by the model. The reason is believed to be two-fold. First, the figures provided by the Fuels Division do not include all the sources of fuel on the island. For instance, port services and the air field both provided the JTF motor fuel but the quantity is not included in the Fuels Division estimate. Secondly, the model calculates fuel consumption based on all the vehicles required being operated on a full-time basis (i.e., all 40 forklifts will be consuming fuel ten hours a day every day). Therefore, the quantity identified by the model is a worst case analysis of the fuel requirements and even if accurate and

complete fuel consumption data was available, the model's consumption rate should exceed the actual consumption experienced.

The data that was available to validate the support equipment planning factor generated by the model is a listing of the JTF's equipment fleet. Again, the data is not perfect. First, the data makes no distinction between the equipment used to support the troops and the equipment used to support the emigrants. Second, the data breaks down the equipment to the smallest end unit. For example, a ROWPU contains a 60 KW generator, a pump, and a water purification unit. The model maintains all the pieces in one unit since that is the way a ROWPU is deployed but, the equipment list identifies each item separately. Third, the data did not identify a usage rate or a vehicle capacity. There is no way of knowing whether or not all the equipment identified as operational was being used or if the items can be compared. The model includes 3000 gallon per hour ROWPUs. All that is identified on the equipment list is ROWPU. Without the capacities of the items there is no basis for comparison. Finally, many of the vehicles used during the operation were listed using nomenclatures that could not be translated to a known vehicle type with the available reference material.

Since the data includes equipment to support both populations, the equipment requirements for both populations will be considered. The first item that will be considered is generators. After including that generators from each of the 14 ROWPUs and the two Air Transportable Hospitals (there are three generators deployed with each ATH), the model identifies the need for 68 generators. Because the generators in the JTF inventory had many different kilowatt ratings, the total kilowatt rating provided will be compared. The kilowatt rating on the generators for the ROWPUs and the general ones included in the model is 60 KW. The kilowatt rating on the hospitals' generators is not known. Since hospitals generally require a great deal more power, it is believed that the generators are at least 60 KW each. Therefore, the model provides 4080 kilowatts of power. The equipment list identifies 10,492 kilowatts of generators. However, included in the equipment list are 7 generators with extremely high kilowatt rating, each more than

700 KW. It is not believed that all of these generators were used to support the emigrants. It is believed that many of the larger generators were used to support the Air Force's Bare Bones packages which were deployed as berthing for many of the troops and all the berthing compartments were air-conditioned. The emigrants did not receive air-conditioning. Although it is not believed any of the larger generators were used to support the emigrants, it will be assumed that two of the five 750 KW generators were used to support the emigrants. This reduces the power allotment to actually support the emigrants to 4242 kilowatts of which 211 kilowatts were not operational. This figure is more in line with the model's output but, the actual power allotted is only speculative.

The model provides 59 forklifts to support the two populations. The equipment list identifies 66 different forklifts and three different cranes. However, only 44 of the forklifts and two of the cranes were operational because the actual operational readiness was much lower than the model anticipated. Considering the forklifts and cranes identified in the equipment list also supported the troops, it is believed that the model's prediction would adequately handle the requirements of the operation even with the reduced readiness level.

The model's predictions for garbage trucks and wreckers matched the equipment list. This implies the model's predictions can handle the requirements as it is believed that the assets identified on the equipment list also serviced the soldiers. As for the sanitation vehicles, the model identified a need for eleven trucks to support the two populations and the equipment list identifies 18. Again, the readiness level is about 20 percent lower than was anticipated by the model. Furthermore, since the capacity of the sanitation vehicles is not known, there is no way to compare to model's output to the actual equipment allotted.

As for the remaining equipment items, nothing definitive can be said. Primary because the equipment list does not give enough information to determine a relationship between the model's predictions and the actual assets. For instance, it is known that water was transported and yet no appropriate equipment could be identified on the equipment list.

D. CHAPTER SUMMARY

This chapter reviewed each class of supply to explain how the planning factors can be applied and to attempt to validate the planning factors derived in this thesis. The comparison data was obtained during Operation Sea Signal. Except for Class I supplies, nothing definitive can be said about the model's ability to predict the actual consumption rates experienced. This is primarily because the comparison data was not very useful which is one of the motivating factors for this thesis in the first place. That is, the data just defined quantities of items not weights, so the actual consumption rates could not be defined. All that can be said is that there is a very high correlation between the types of items included in the model and the items actual used in Operation Sea Signal. This should not negate the validity of the planning factors in the eyes of the planners as Operation Sea Signal is very unique. Very few past operations involve supporting two entirely different populations for such a long time. Moreover, many of the assumptions used to derive the model's planning factors, like allocation rates, are purely speculative. Perhaps, if the Commander's true intentions regarding the distribution of supplies were known or if the data was useful, more correlation would have been seen. It should be noted that planning factors are planning tools themselves and the actual validation process takes many years. The first step that should be taken to progress the validation process is to collect suitable comparison data.

V. COMPUTER ASSISTED PLANNING AID

A. INTRODUCTION

The purpose of the computer interface is to put the methodology developed in this thesis in a format that would facilitate its actual use. In essence, the program allows the planner to generate planning factors for various scenarios using the methodologies identified in this thesis without learning the cumbersome methods, algebra, and arithmetic. The program was developed using a Windows™ based Microsoft® product known as Visual Basic™. Visual Basic™ was chosen first, to comply with DOD's transition to Microsoft® products and second, for the outstanding user interfaces it can produce. Furthermore, Visual Basic™ can produce stand-alone executable files, one of which is the program developed to complement this thesis. The program is called the Humanitarian Operations Planning System (HOPS). The details of the program are explained in this chapter.

This chapter will take the user through the various HOPS screens explaining the appropriate inputs and the associated outputs. All the screens displayed will be using inputs relating to Operation Sea Signal in Guantanamo Bay, Cuba. This is to allow the user to see the relationship between the inputs and the outputs. This is possible because the outputs were already derived in the previous chapter. Although the order in which the screens are presented is also the desired method for reviewing the classes of supply,. the user is not limited to reviewing the classes of supply in this order. However, the user should remember that Class VII and Class III items should be the last classes of supply considered because they are heavily dependent on the requirements generated by the other classes of supply.

B. OPERATION

All that is required to run HOPS is a computer with Windows™ software. Although the speed of the program may be reduced, the program does not need to be loaded on a hard drive. It can be successfully operated from an external or internal floppy drive. To run the program from a floppy drive, the user needs to insert the diskette in an appropriate floppy drive and type HOPS.EXE at the MS-DOS® prompt for the respective floppy drive. To run the program from the hard drive the user has two options. The user can create a program item in Windows™(see the Windows™ manual) or type HOPS.EXE from the MOS-DOS® prompt.

Another piece of hardware that speeds the use of the program is a mouse. The use of a mouse is strictly optional as the program has been written in such a way that the keyboard can sufficiently access all the necessary data. If no mouse is available, the planner can transverse a screen using the TAB key or shortcut keys. Shortcut keys are available whenever a button, option, or check box has a letter in its title underlined. For instance, most screens provide an options menu. If the O in the word options is underlined, the user should press ALT + O to access the options menu.

The model provides planning factors in a per person per day quantity. However, if there was any question as to whether the traditional planning factor would be useful or not, like Class II items, the model does provide the option to display a per person per issue quantity. When the user needs to determine the surge requirements, the per person per day planning factor provided by this model needs to be multiplied by the desired days of supply and the population size. The per person per issue planning factor just needs to multiplied by the population size to acquire a minimum of 60 days of supply.

Finally, the program has been designed so that if errors in the underlining planning factors, item weights, or item life cycles are identified, only changes to the main module are required. All the other code operates independently and will not be affected by a change in the underlining planning factors.

1. Greeting Screen

Upon execution of the program, the screen similar to Figure 5.1 will emerge. This screen is called the Greeting Screen. The sole purpose of this screen is to allow individuals that have inadvertently started the program to exit. If the YES button is selected the program will be started. If the NO button is selected, the user will exit the program. If the user makes no entry in two minutes, the program will be automatically aborted.

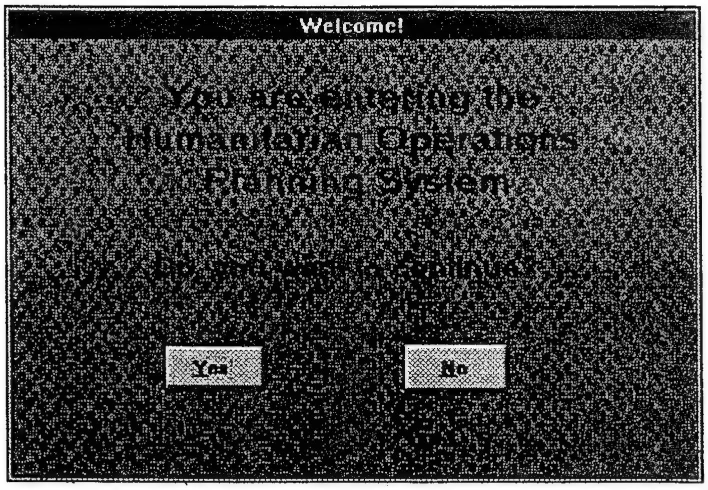


Figure 5.1. HOPS Greeting Screen

2. Planning Screen

As Figure 5.2 illustrates, the Planning Screen is divided into five sections that correspond with the variables in the model. The first section is the Population Demographics section. When the screen is first displayed all values are zero and the cursor is set at the population size input box. The user is to enter the appropriate population size. If the user attempts to enter non-numeric symbols, an error will result. To clear the error, the OK button must be chosen. Once the error is cleared the user will be prompted back to the population size input box to try again. Next, the demographics are inputted as percentages. That is, if one percent of the population is infants, the user will just enter 1, not 0.01, in the input box labeled infants. The user can use the TAB key

or click the left button on their mouse to select the desired input box and transverse the various demographic categories. Again, any attempt to enter non-numeric symbols will result in an error that is cleared as discussed previously.

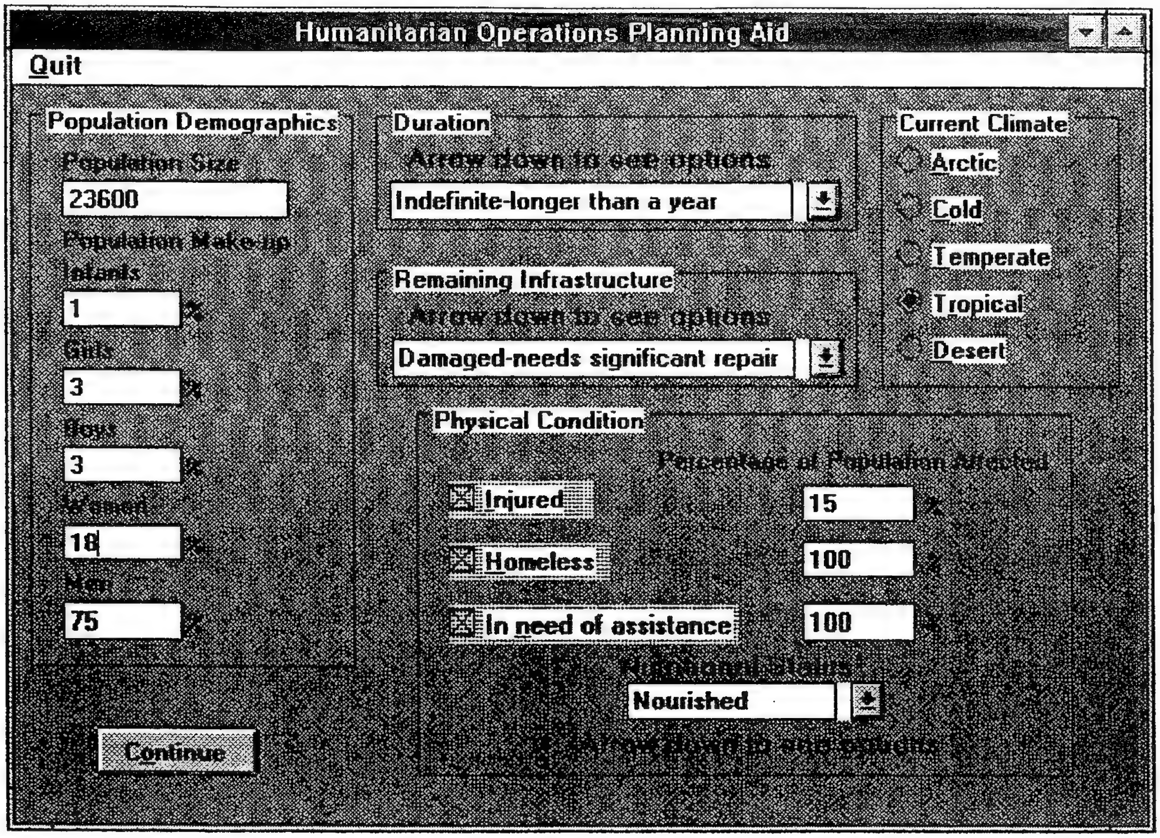


Figure 5.2. HOPS Planning Screen

The next section is used to identify the duration of the operation being considered. The section consists of a drop-down menu. There are two ways to access the menu. First, the user can use the TAB key to access the duration block and then use the keyboard direction arrows to select the desired duration. The second option the user has to access the menu is to use a mouse to click the down arrow on the menu box and then click on the duration they desire. If this block is not completed before continuing, an error will identify the deficiency. Again, the error can be cleared by clicking the OK button or by pressing the enter key on the keyboard. The Remaining Infrastructure portion of the

screen is set up exactly like the Duration section. The section is completed in the same fashion and a similar error results if the block is not completed.

The next section is used to identify the climate of the operating area. All five options are seen at run time. To select a climate, the user may choose the desired option with the mouse or by using the appropriate shortcut keys. If no climate is selected, an error will result. The error is cleared by selecting the OK button.

The Physical Condition portion of the screen is broken into two parts, as is the model. The first portion requires the user to identify or estimate the physical state of the population and what percentage of the population is affected by the associated physical condition. For example, if 25 percent of the population is injured in some way, the user would check the Injured block and enter 25 in the Percent Affected box which is directly adjacent to the Injured check block. Again, the blocks can be accessed using a mouse or the TAB keys. The check boxes are marked by using the shortcut keys discussed previously or by selecting the desired physical condition block using the mouse keys. The Percentage of the Population Affected block is accessed in the same matter as the Population Demographics blocks. If the user attempts to enter non-numeric symbols or the percentage, the user will receive an error. Once the error is cleared by selecting the OK button, the user will have the option to try inputting again. The second part of the Physical Condition section of the screen is the Nutritional Status block. It operates in the same manner as the Duration and the Remaining Infrastructure blocks. The user may choose the down arrow on the menu to drop down the menu options or TAB to the menu and use the arrow keys on the keyboard to select the appropriate nutritional status.

Once the user has finished entering the variables, the CONTINUE button must be selected to proceed. This button verifies the entries and points out any additional errors. For instance, if the population demographics do not total to 100, an error will result. If a physical condition is checked and no percentage of the population is identified for that condition, an error will result. All the errors are cleared by selecting the OK button. When the error is cleared, the user is prompted back to the site of the error to make the

appropriate corrections. The user must select the CONTINUE button again, after making corrections, before the program will proceed.

Finally, if the user has accidentally entered the program or wishes to exit the program while the planning screen is displayed, the Quit option in the upper left hand corner of the screen can be selected. Selection of the Quit option will result in a message screen telling the user the program is being exited. If the user truly wishes to quit, the OK button should be selected. Otherwise, the CANCEL button should be selected.

3. Input Review Screen

The Input Review Screen, Figure 5.3, allows the user to verify the entries made in the Planning Screen. All the variables selected by the user will be displayed. The entries can not be modified on this screen. Any attempt to modify the displayed figures will result in an error. If the user feels that any of the entries are in error, the UPDATE button can be selected. When the UPDATE button is selected the Planning Screen will be displayed again so the user can make the desired changes. If all the entries are satisfactory, the user can select the CONTINUE button for the program to proceed. If the user wishes to exit the program, the QUIT option in the upper left hand corner of the screen can be chosen.

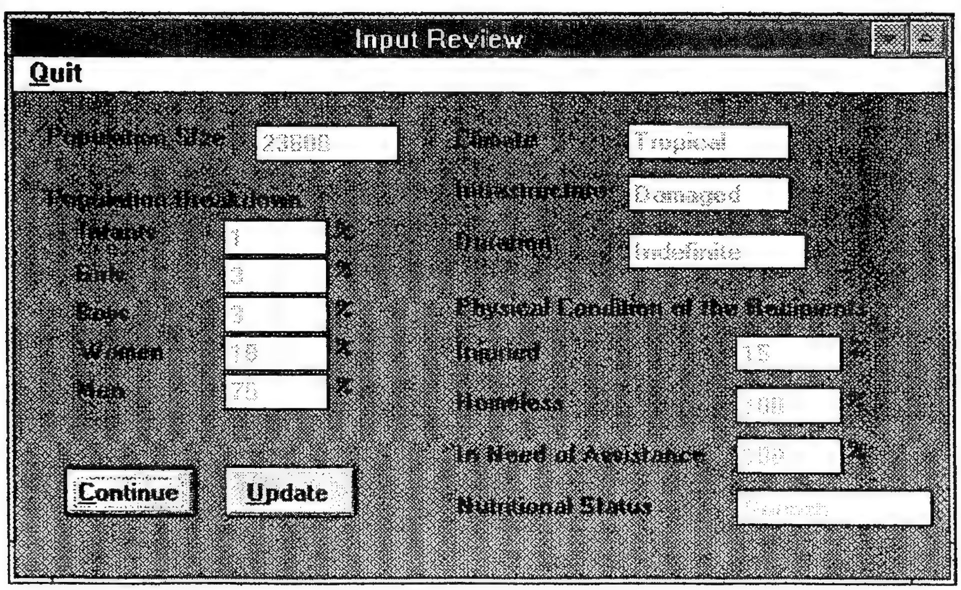


Figure 5.3. HOPS Input Review Screen

4. Planning Factors Screen

Figure 5.4 is the Planning Factors Screen and it allows the user to select the class of supply he is interested in analyzing. Selection of a class of supply button will result in the respective class of supply requirements screen being displayed. Each screen will be discussed shortly. Access into the various classes of supply depends on the variables that were defined. For example, if a brief or temporary duration was selected, Class X can not be accessed. In any case, the user is notified. If the user still wishes to access the class of supply in question, the Options menu can be selected and the Update option can be chosen. When this option is chosen, the Planning Screen is redisplayed and the user can make the appropriate changes to the variables to access the class of supply desired. In the example discussed above, the user would have to change the duration of the operation to extended or indefinite.

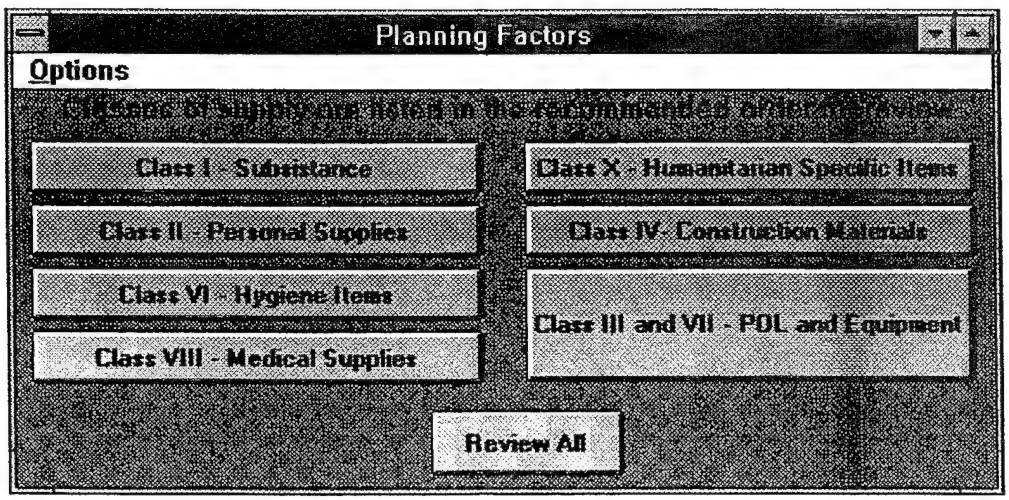


Figure 5.4. HOPS Planning Factors Screen

Once the user has analyzed all the classes of supply, he may choose to review what has already been calculated by pressing the REVIEW ALL button. When the REVIEW ALL button has been selected the Review All screen is displayed which will also be discussed shortly. Again, if the user wishes to exit the program, the Quit option can be chosen on the Options menu.

a. Class I Requirements Screen

This screen is broken into five sections as illustrated by Figure 5.5. Four of the five sections require user input. The final section computes the Class I planning factors for the operation in question. The first section requiring user input is the Demographics section. If the portion of the population requiring assistance was identified as less than 100 percent in the planning screen, the user is given the opportunity to update the demographics for the portion of the population receiving assistance. Otherwise, the demographics previously indicated will be displayed and no further user input is required.

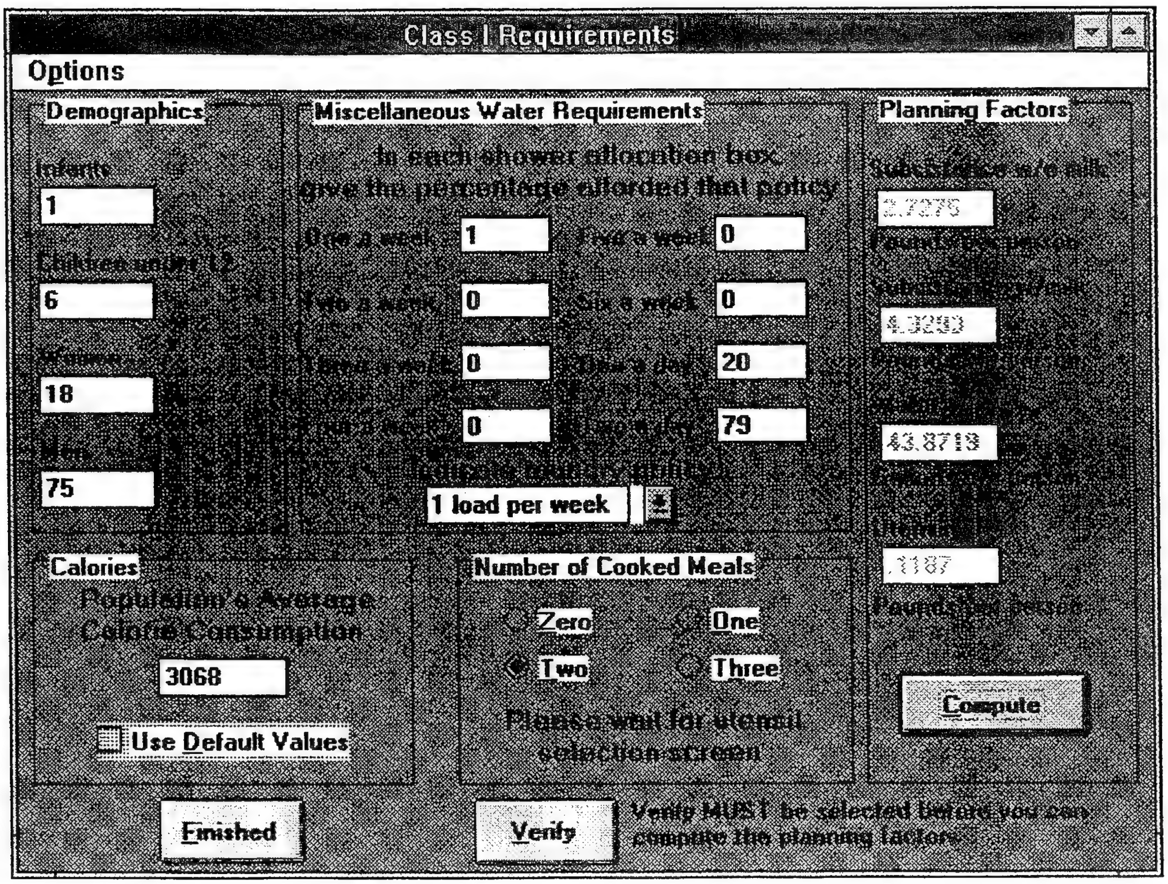


Figure 5.5. HOPS Class I Requirements Screen

In the Miscellaneous Water Requirements section, the user is to identify the shower and laundry policy that will be established. This is accomplished by indicating

what proportion of the population will be afforded the various number of weekly or daily showers. That is, if the whole population will be allotted one shower a week, 100 should be entered into the input box labeled "one a week." To identify the laundry policy, another drop-down menu is used and is operated as previously discussed. Errors result in this section if the user tries to enter non-numeric characters in the proportion boxes, if the proportions do not sum to one, or if the user fails to complete either section.

Next, the user needs to estimate the population's calorie consumption. If the user is unable to assess or research the nutritional status of the population, the default values can be used. However, the user must be aware that the default values may be high or low for some areas. The values are based on the recommended daily allowance chart found in Appendix C. When the Default Value box is selected, the Default Calorie Range screen, Figure 5.6, will appear to allow the user to indicate whether the recipient population is believed to be in the upper ten percent of their nutritional category, at the average of the category, or in the lower ten percent of the category. Once the user has selected the desired category, the OK button should be selected to continue the program.

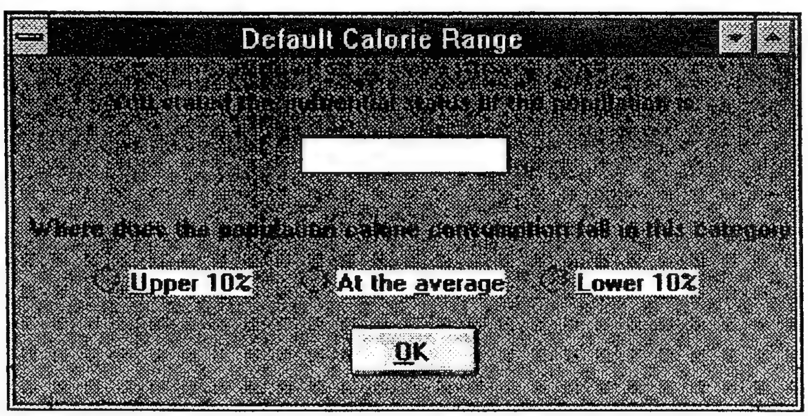


Figure 5.6. HOPS Default Calorie Range Screen

The final section requiring user input is used to identify the number of cooked meals that will be served to the population. This section serves two purposes. First, it identifies the portion of the water planning factor corresponding to food

preparation. Second, it is used to determine the required utensils planning factor. The desired category is selected using the appropriate shortcut keys or selecting the desired option with the mouse. Selecting any category other than "zero," will result in an Information on Required Utensils screen, similar to Figure 5.7, being displayed. Each category has a different Information on Required Utensils screen based on the number of meals selected. In any case, the user should enter the appropriate utensils and select OK to continue. If no utensils are selected, an error will result.

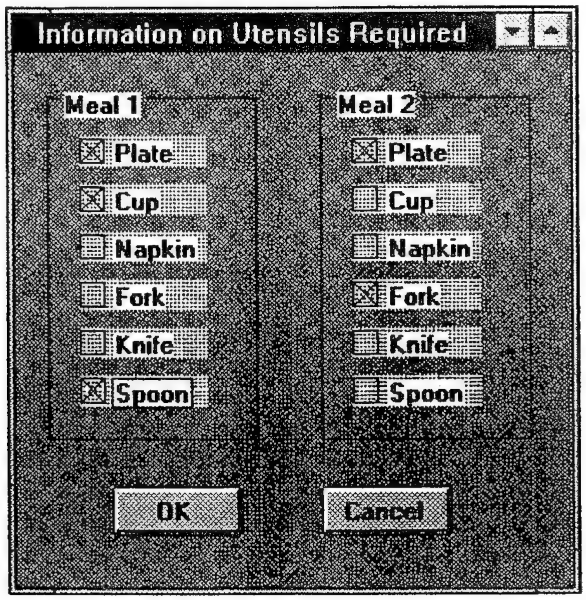


Figure 5.7. HOPS Information on Required Utensils Screen

Once the user has completed the Class I Requirements form, the VERIFY button must be selected before the planning factors can be computed. The VERIFY button ensures the user has correctly entered all the pertinent information and prompts the user to make corrections if necessary. Once all the inputs have been verified, the user can press the COMPUTE button. This button takes all the user inputs and outputs the appropriate planning factors.

Once the user has computed the planning factors, he may want to explore other combinations of the variables. Any number of combinations can be tested. The only

requirement is that the planner press the VERIFY button before the COMPUTE button each time. After the user has finished exploring the various combinations, he has several options to leave this screen. The Options menu can be selected and the user can select the New Class of Supply option, the Update option, or the Quit option. The New Class of Supply option will return the user to the Planning Factors screen, Figure 5.4, so that the other classes of supply can be reviewed. It should be noted that when the user leaves this screen, the last inputs will be saved. The Update option returns the user to the Planning Screen to revise the initial inputs and, the Quit option leaves the program. The user also has the option to select the FINISHED button. When the user selects the FINISHED button, the Options Screen, Figure 5.8, is displayed. This screen offers two choices. The user can either return to the Planning Factors screen or quit the program. If the QUIT button is selected in error, the user should press the CANCEL button on the message box and he will be returned to the Planning Factors Screen to continue.

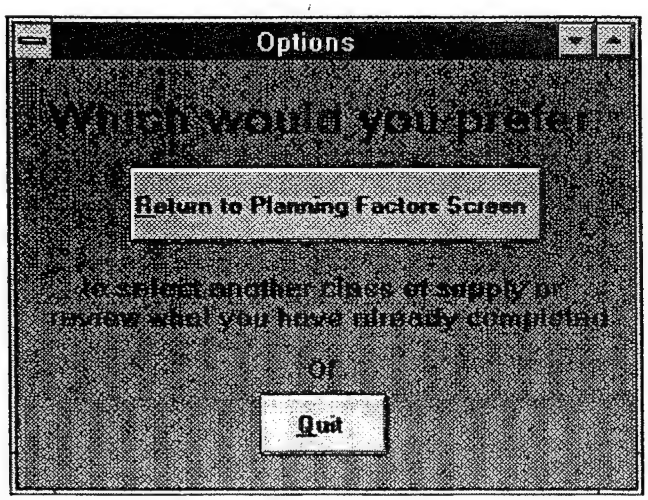


Figure 5.8. HOPS Options Screen

b. Class II Requirements Screen

Much like the Class I Requirements screen, the Class II Requirements screen, Figure 5.9, is split into five sections. However, only three of the sections on this screen require user inputs. Again, if the user has identified the percentage of the

population that requires assistance to be less than 100 percent, the user will be prompted to update the demographics when the screen is displayed. The climate section is just to remind the user what climate was selected on the Planning Screen. This is important because it is one of the major factors that affect the quantities of Class II items required.

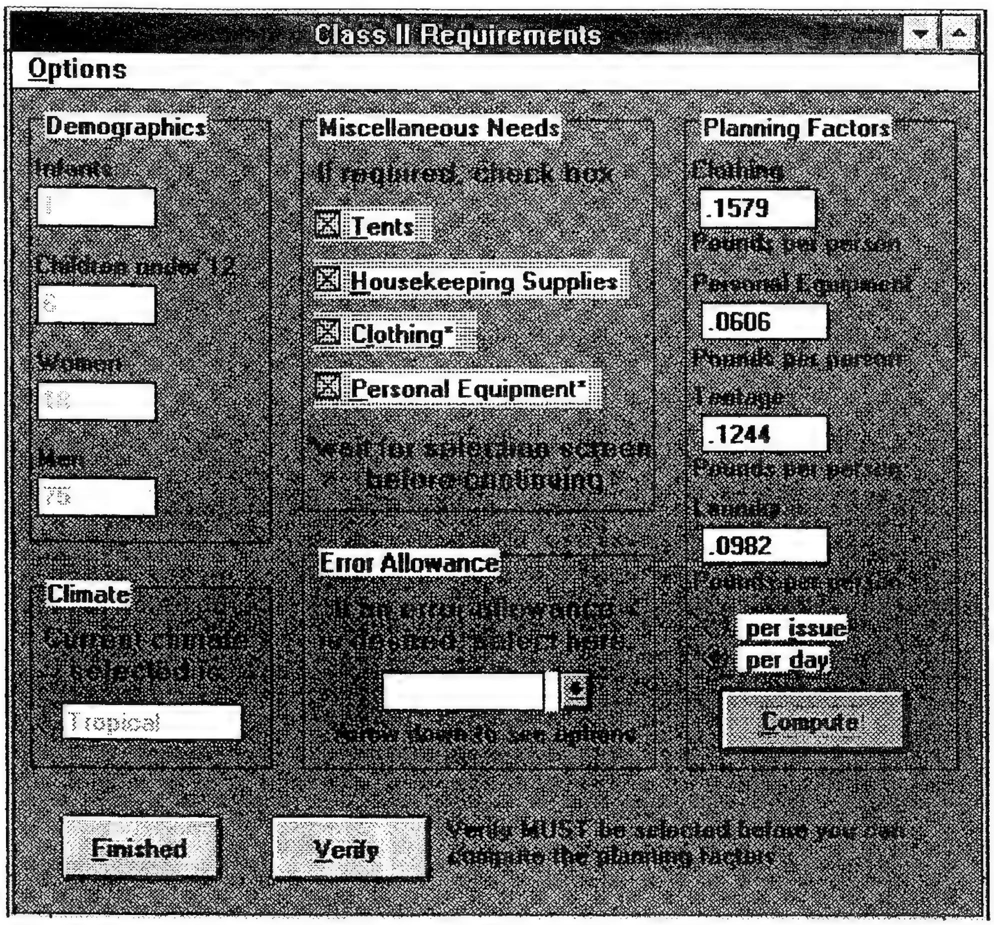


Figure 5.9. Class II Requirements Screen

The Miscellaneous Needs section is the heart of this screen. To display the appropriate planning factors, the user is to select the items that he wishes to distribute to the recipient population. If tents are required to house the population, the Tents check box should be selected. If housekeeping supplies are required, the Housekeeping Supplies check box should be selected. When this box is checked the Housekeeping Requirements screen, Figure 5.10, is displayed. If clothing is to be distributed, the Clothing check box

should be selected. Checking the Clothing check box results in the Clothing Requirements screen, Figure 5.11, being displayed. When this screen is displayed, the user is to indicate the quantity of each of the different items he wishes to distribute per person. When the screen is completed, the OK button needs to be selected. This button verifies the user's entries, notifies the user of any entries that are in conflict with the current climate or appear excessive, and makes the appropriate corrections before returning the user to the Class II Requirements screen. The Personal Equipment check box is selected when personal equipment is to be offered to the population. When it is selected the Personal Equipment screen, Figure 5.12, is displayed. Again, the user is to select the required items and select the OK when finished. If any unusual entries are made the user will be prompted to make appropriate changes. It is important to note that the program limits the amount of each item that can be distributed to five.

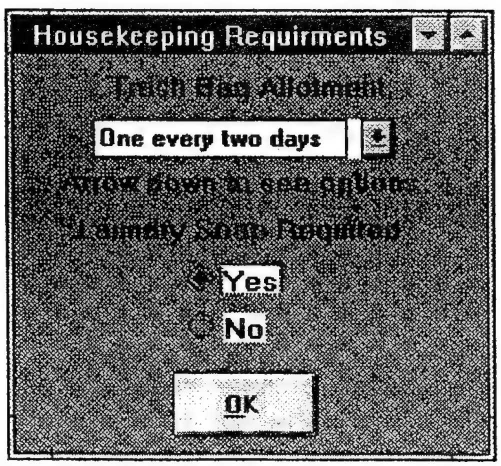


Figure 5.10. HOPS Housekeeping Requirements Screen

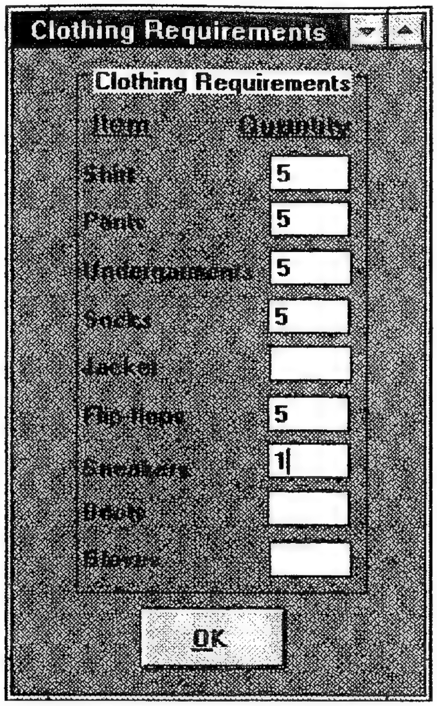


Figure 5.11. HOPS Clothing Requirements Screen

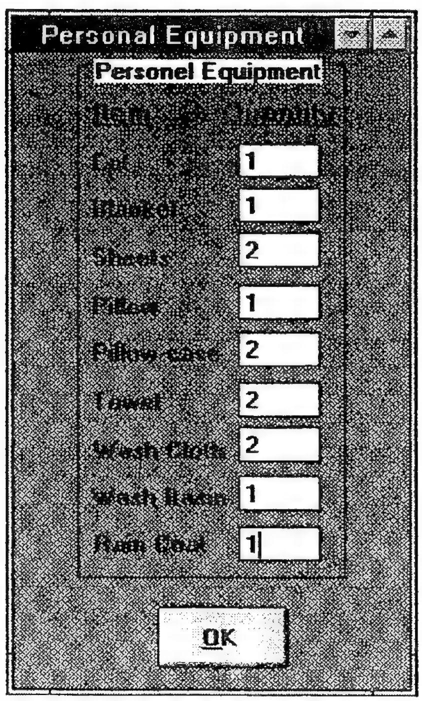


Figure 5.12. HOPS Personal Equipment Screen

Once the user has completed the Miscellaneous Requirements section of the screen, the user has the option of selecting an error allowance. The error allowance is provided because of the large variation in the weight of clothing and personal equipment among manufacturers. To select an error allowance, the user must select the Error Allowance menu box and use the down arrow on the keyboard to view the options. Once the screen is completed to the user's satisfaction, the VERIFY button must be selected. Again, the VERIFY button checks all entries for errors and prompts the user if corrections are required. Finally, the COMPUTE button can be selected to display the planning factors. This screen gives the user two options when displaying the planning factors. The user can display the planning factors in a per person per day quantity (the default) or a per person per issue quantity. The display choice can be selected by using the shortcut keys on the option buttons.

This screen also provides the user the opportunity to experiment with the various provisions that are provided to the recipient population. The only requirement is that the VERIFY button be selected after all entries are updated before the COMPUTE button is selected. When the user is finished evaluating Class II items, this screen provides the same options as the Class I Requirements screen to leave the screen. Again, the Options menu can be selected and the user can select one of the following: the New Class of Supply option, which will return the user to the Planning Factors screen; the Update option, which returns the user to the Planning Screen; or the Quit option, which leaves the program. The final option is to select the FINISHED button which displays the Options Screen (shown in Figure 5.8). From the Options screen, the user can either return to the Planning Factors screen or quit the program. It should be noted that when the user leaves this screen, the last inputs will be saved.

c. Class VI Requirements Screen

The Class VI Requirement Screen is very simple, see Figure 5.13. The user has a maximum of three inputs. First, if the percentage of the population requiring assistance is less than 100 percent, the user has the option to update the demographics like

the Class I and Class II Requirements screens. Secondly, the user is to identify whether or not Class VI items are required. If the items are required, the user should select the Class VI Items are Required button. Finally, the user is to press the COMPUTE button to calculate the appropriate planning factor. Like all the previous screens, the Class VI Requirements screen has the same options to leave the screen once the calculations are completed.

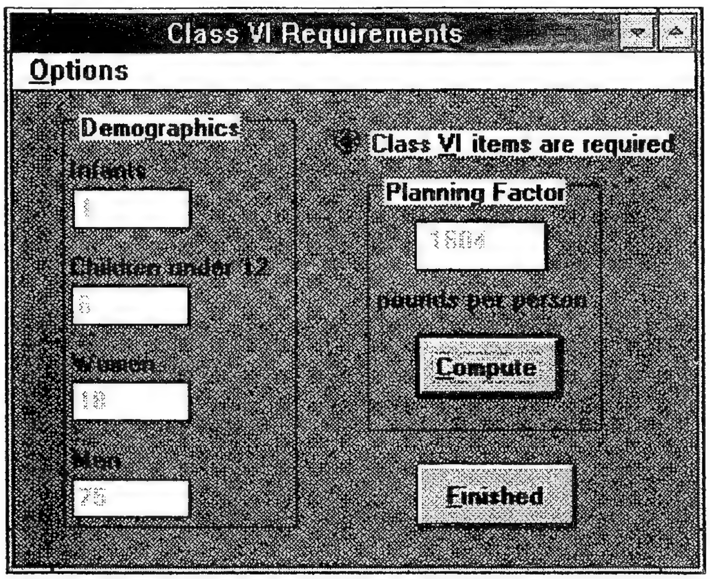


Figure 5.13. HOPS Class VI Requirements Screen

d. Class VIII Requirements Screen

The medical supply requirements in this model are driven by the bed allocation policy in the theater of operations and is the only user input required as illustrated by Figure 5.14. Based on the user's input regarding the percentage of the population that is injured on the Planning Screen, the default bed allocation policy will be established. If the user chooses to override the default values, the user has to select the option he prefers. Once the preferred option is selected, the user must select the VERIFY button before the planning factors can be computed. Then, the COMPUTE button can be selected to calculate the appropriate planning factor. Again, the remaining options mirror those of the previous requirement screens.

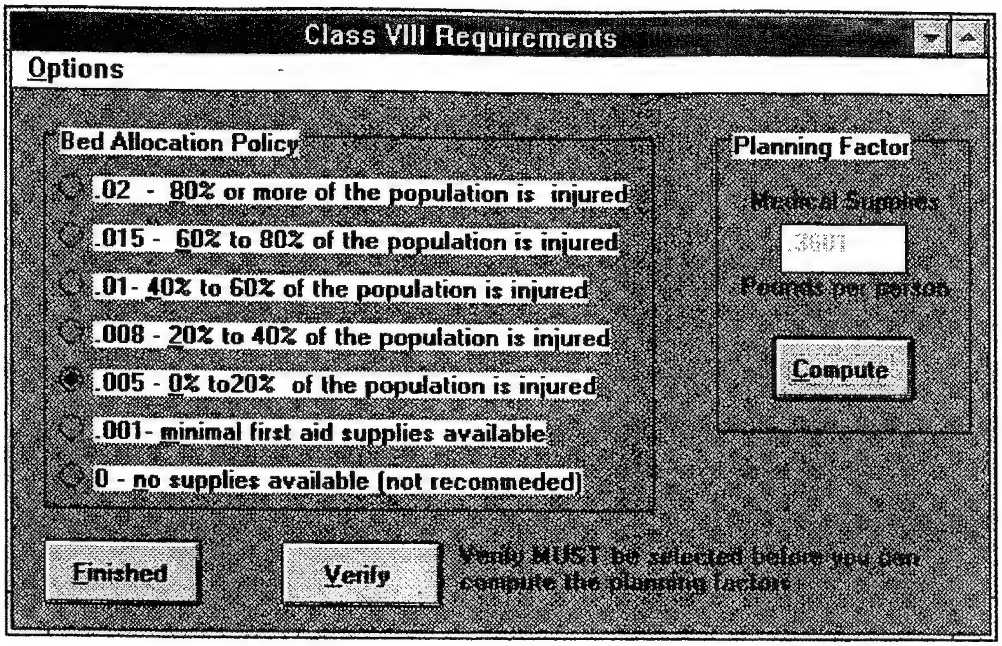


Figure 5.14. HOPS Class VIII Requirements Screen

e. Class X Requirements Screen

When the duration of the operation exceeds six months, the planner may be required to ascertain the planning factors relating to humanitarian specific items or quality of life items. To complete calculations, the Class X Requirements screen, Figure 5.15, can be used. Upon selecting this screen, the demographics of the population will be displayed. If the percentage of the population in need of assistance is not 100 percent, the user will be prompted to update the demographics. There are four types of items that the planner can consider: individual issue items, community issue items, school supply items, and resupply items. Each type of item can be reviewed by selecting the item's associated check box.

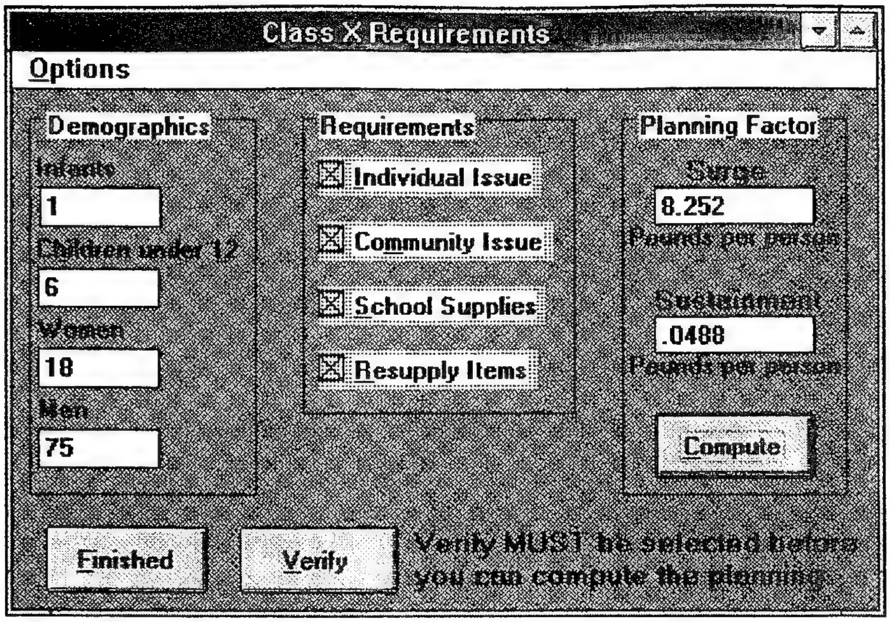


Figure 5.15. HOPS Class X Requirements Screen

If the user selects the Individual Issue check box, the Individual Issues screen, Figure 5.16 is displayed. On this screen the user has only to select the items that are required by selecting the check box associated with the item desired. If the user wishes to include items that are not considered by the model, the user is required to input the per item weight in the Additional Allowance section. When all the desired items are selected, the user should select the OK button to return to the Class X Requirements screen. Similarly, checking Community Issue check box will result in the Community Issues screen, Figure 5.17, being displayed. The user should select the items desired by selecting the item's associated check box and indicate the allocation rate or distribution rate that will be used. To indicate the desired allocation rate, the user must select the appropriate allocation rate in the Issue Rate drop-down menu. Again, the planner is provided the option to enter the weight of any addition community issue items that are required in the Additional Allowance text box. To continue the program, the user should select the OK button which will return the user to the Class X Requirements screen.

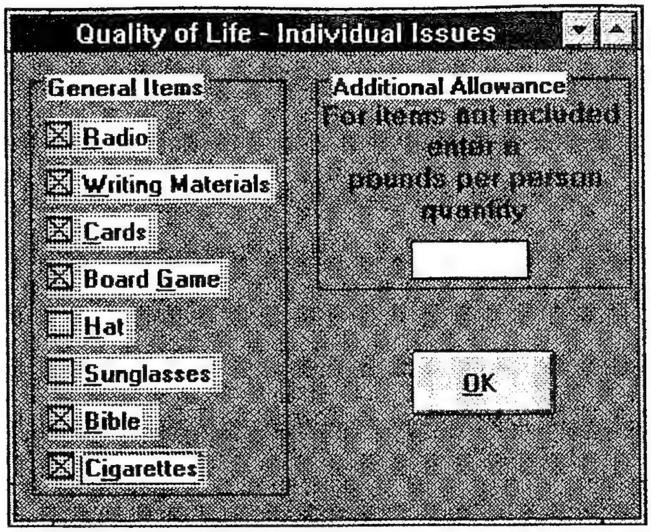


Figure 5.16 HOPS Individual Issues Screen

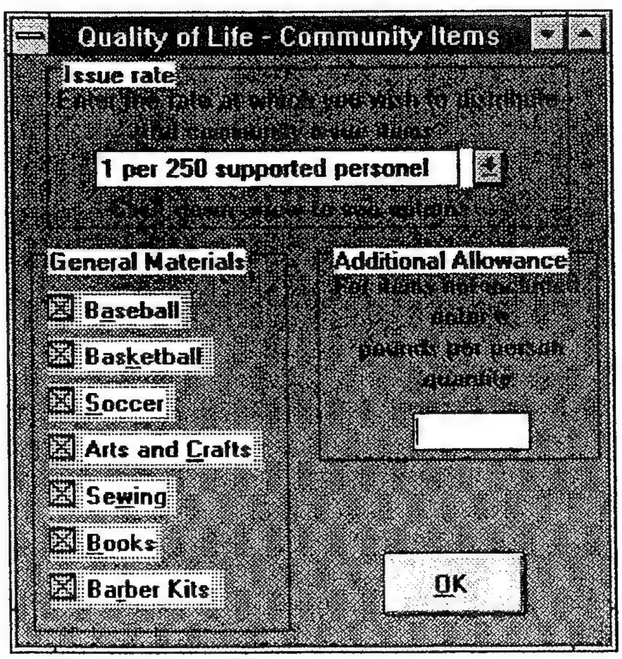


Figure 5.17 HOPS Community Issue Screen

If the need to establish schools is identified, the School Supplies check box should be selected. Checking the School Supplies check box will display the School Supplies screen, Figure 5.18. The user should select the school items that are required and then identify the percentage of the population requiring schooling. The items that are required are identified by selecting the item's associated check box while the percentage of the population requiring schooling is identified by entering the appropriate percentage in the Schooling Requirements section of the screen. To return to the Class X Requirements screen to compute the planning factor, the OK button should be selected.

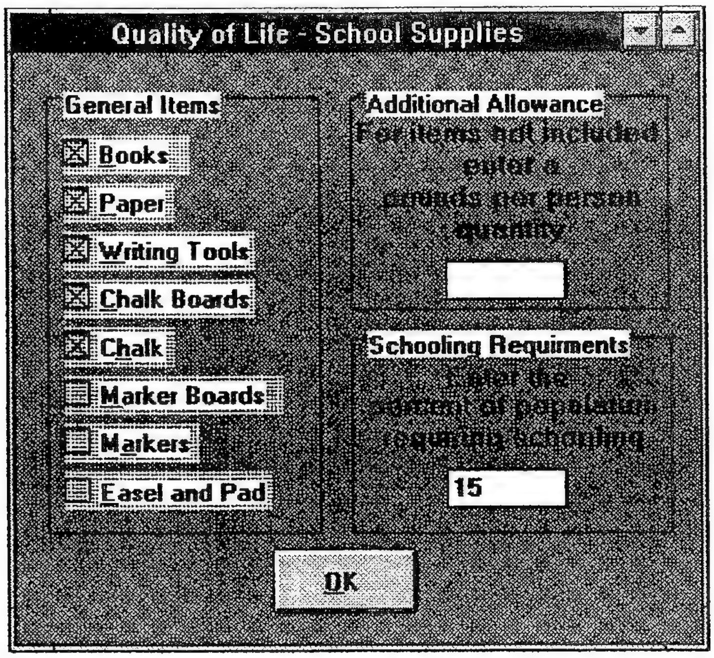


Figure 5.18. HOPS School Supplies Screen

Finally, the Resupply Requirements screen, Figure 5.19, will be displayed if the Resupply Items check box is selected. When this screen is displayed, all the resupply requirements associated with the items selected in the previous three screens will already be selected. If the user does not wish to alter these requirements, the user should select the OK button to return to the Class X Requirements screen. However, if the user does not wish to resupply all the items selected, the user should check the associated item's

check box to deselect the item. In addition, if there are any additional items the planner wishes to consider resupplying, the user can either select the item's associated check box or enter the resupply weight into the Additional Allowance section of the screen, whichever is applicable.

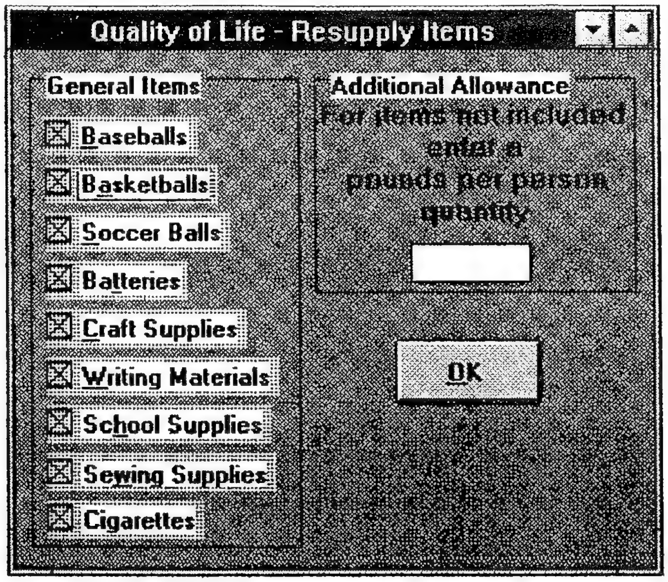


Figure 5.19 HOPS Resupply Screen

After the user has reviewed all the items that are to be distributed to the population, the VERIFY button should be selected to allow the Class X planning factors to be calculated. To initiate the calculations, the COMPUTE button must be selected. Selecting this button will result in two planning factors being displayed. The first planning factor is the pounds per person per day planning factor required for the initial surge. The second planning factor is the pounds per person per day required for sustainment. To continue the planning process, the user may use any of the previously discussed options for leaving a requirements screen.

f. Class IV Requirements Screen

To determine the construction materials required to support an operation, the Class IV Requirements screen, Figure 5.20, can be displayed. When the Class IV

requirements screen is displayed, the size of the population being supported, the condition of the infrastructure, and the climate is displayed in the Current Conditions section of the screen. To include construction material in the analysis, all the user has to do is select the desired construction materials by selecting the associated item's check box. Once all the desired items are selected the user must select the VERIFY button and then the COMPUTE button to display the appropriate planning factor. After the user is finished experimenting with the Class IV requirements, the user may exit the screen by selecting the FINISHED button or by choosing one of the options in the Options menu.

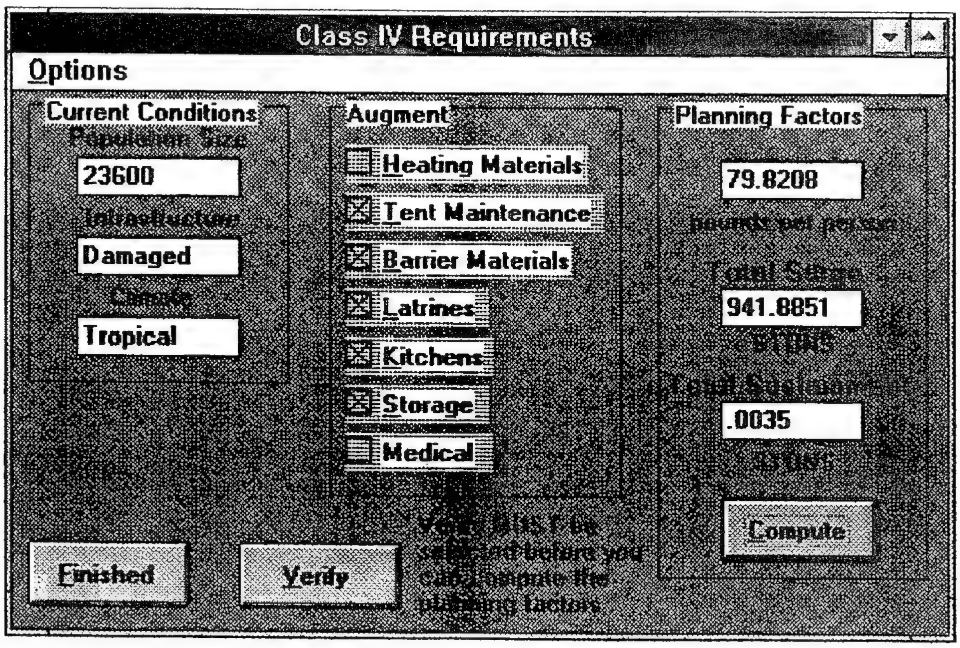


Figure 5.20. HOPS Class IV Requirements Screen

g. Class VII Requirements Screen

After the user has identified all the material requirements for the operation, the Class VII or support equipment requirements can be determined. *If the user alters the material requirements after completing this screen, he must return to this screen to re-compute the support equipment requirements.* Therefore, this should be the last screen

entered in the planning process. This is the most complicated screen in the HOPS program so, the user should make his entries carefully.

Upon entering the Class VII Requirements screen, Figure 5.21 will appear and the user must determine whether to calculate the support equipment requirements for the surge or sustainment portion of the operation. This is done by selecting the appropriate button from Supply Movement box. It should be noted that in most operations, the surge movement requirements will need the most vehicles. It is recommended, but not required, that the user compute the requirements related to surge movement. Once the appropriate button is selected, the short ton (STON) quantity of supplies is displayed. If neither option is selected, an error will result.

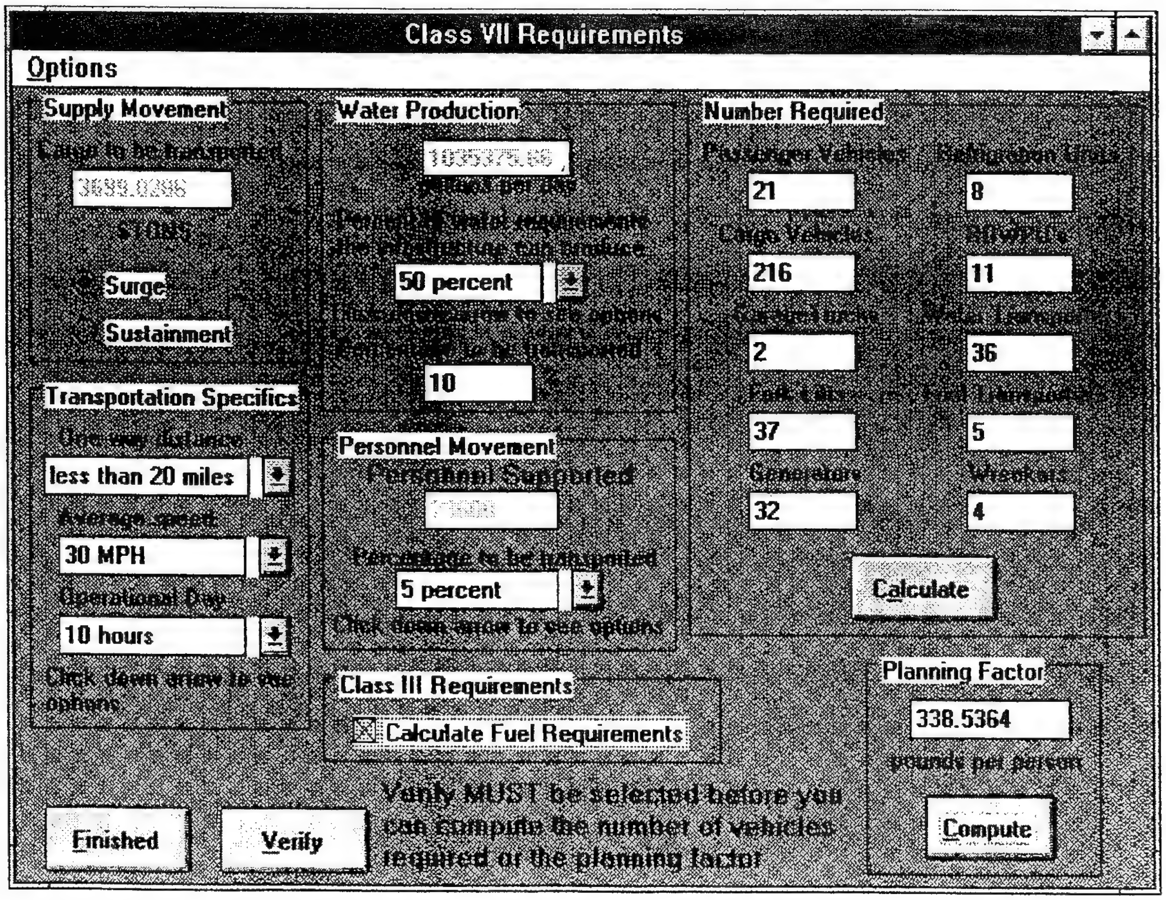


Figure 5.21. HOPS Class VII Requirements Screen

The next section to be completed is the Transportation Specifics section. There are three drop-down menu boxes in this section, the One-way Distance menu, the Average Speed menu, and the Operation Day menu. The One-way Distance menu is to identify the average one-way distance that must be traveled by the vehicles. The Average Speed menu box is to identify the speed at which the vehicles will be traveling. The Operational Day menu box is to identify the number of hours the vehicles will be operated each day. Again, the options for each box are displayed by selecting the box and using the down arrow keys on the keyboard or by clicking on the down arrow with a mouse. Failure to complete any one of the boxes will result in an error.

The next two sections, Water Production and Personnel Movement, are used to identify the need for vehicles to transport water and personnel respectively. If the need for water has been identified, the quantity of water required each day is displayed. The user has only to input the percentage of the water requirements that the infrastructure is capable of producing and the percentage of the water that must be transported. If no water is required, no entries are required by the user. However, in the Personnel Movement section, the user must always enter the percentage of the population that requires transportation each day. If no movement is anticipated, the user can select zero from the menu options. Again, errors result when the user fails to complete the applicable boxes.

Once all the user entry boxes previously described have been completed, the user must select the VERIFY button to continue. Once the VERIFY button has been selected, the user can calculate the fuel requirements or the planning factor. If the user does not wish to calculate the fuel requirements, the CALCULATE button should be selected. A message box will then be displayed to notify the user that the calculated values will be inaccurate since the fuel requirements have not been identified and will ask the user if he wishes to continue. The user has only to select the YES button to continue. However, if the user truly wishes to calculate the fuel requirements first, the NO button should be selected. Selecting the NO button allows the user to check the Calculate Fuel

check box. Checking this box, either before or after the CALCULATE, will result in the Class III requirements screen being displayed. When the Class III requirements screen is completed, which will be discussed shortly, the user will be returned to the Class VII requirements screen.

Once the user returns to the Class VII requirements screen, the CALCULATE button can be selected without an error resulting and the Number Required boxes will display the calculated requirements. The user can then select the COMPUTE button in Planning Factor section to compute the corresponding planning factor. Finally, the user can leave this screen using any of the previously discussed exiting methods.

h. Class III Requirements Screen

This screen can only be accessed through the Class VII requirements screen since the requirements for fuel are primary driven by the amount of support equipment utilized during the operation. Upon entering the Class III Requirements screen, Figure 5.22, all the current equipment requirements are displayed. There are no user entry blocks on this screen. All the user has to do to display the fuel statistics is to select the VERIFY button. This not only computes the diesel and gas requirements but it also computes the number of fuel trucks that are required and their associated fuel requirement. Selecting the COMPUTE button in the Planning Factor section will result in the traditional pounds per person per day planning factor being displayed.

This screen does not allow the user to explore the variables. Any contingency planning must be done in the other requirement screens. This screen only responds to the previously inputted requirements. In addition, there are only two ways to leave this screen. First, the user can select Quit from the Options menu and exit the program. Secondly, the user can select the FINISHED button and return to the Class VII Requirements screen.

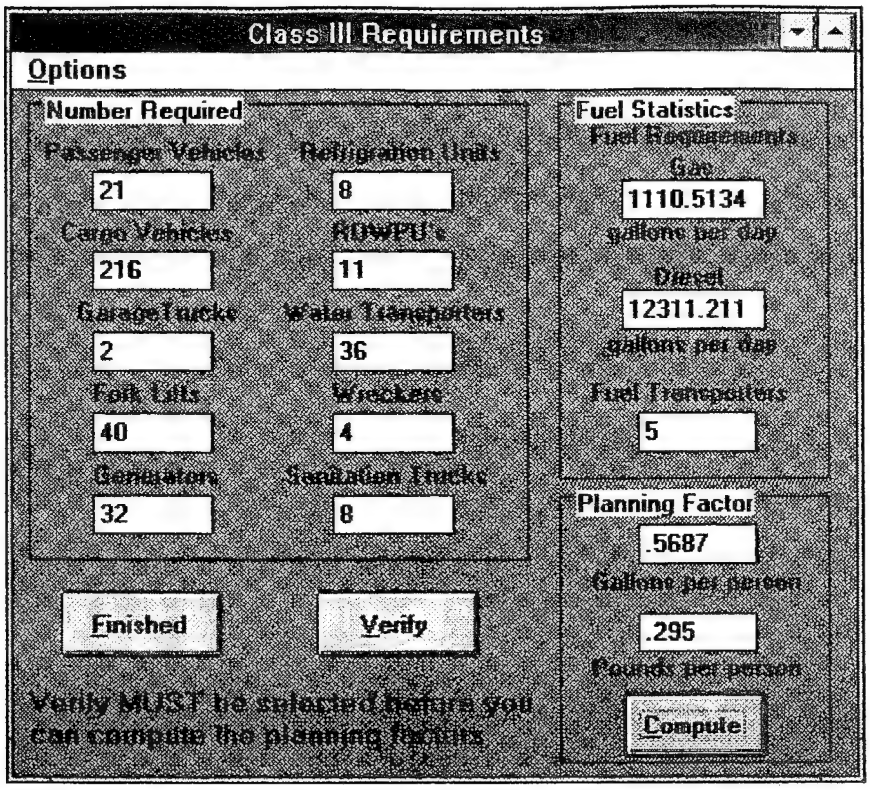


Figure 5.22. HOPS Class III Requirements Screen

5. Review All Screen

Once the user has finished reviewing the applicable classes of supply, he has the option to select the Review All screen. This screen, Figure 5.23, can be selected from the Planning Factors Screen (Figure 5.4) by selecting the REVIEW ALL button. Once the user has accessed this screen, all the planning factors the user has reviewed at that point are displayed in the traditional pounds per person per day quantity. The user has the option of displaying the aggregate pounds of supplies required for the surge and sustainment phases of the operation by selecting the COMPUTE button. When the COMPUTE button has been selected, the surge and sustainment requirements will be displayed. It should be noted that the surge quantity contains all items that are issued from day one as well as an additional fifteen days of supply when applicable. The number of days of supply contained in the surge requirements can be altered by selecting the desired number days from the Days of Supply Required box and then selecting the

COMPUTE button. The sustainment requirements are measured in pounds per day and included only items that are consumed on a daily basis. That is, classes of supply whose pounds per person per day planning factor does not seem appropriate, like clothing and quality of life items, are not included. These figures will prove invaluable to the logistician planning the lift assets required to support and sustain humanitarian operations.

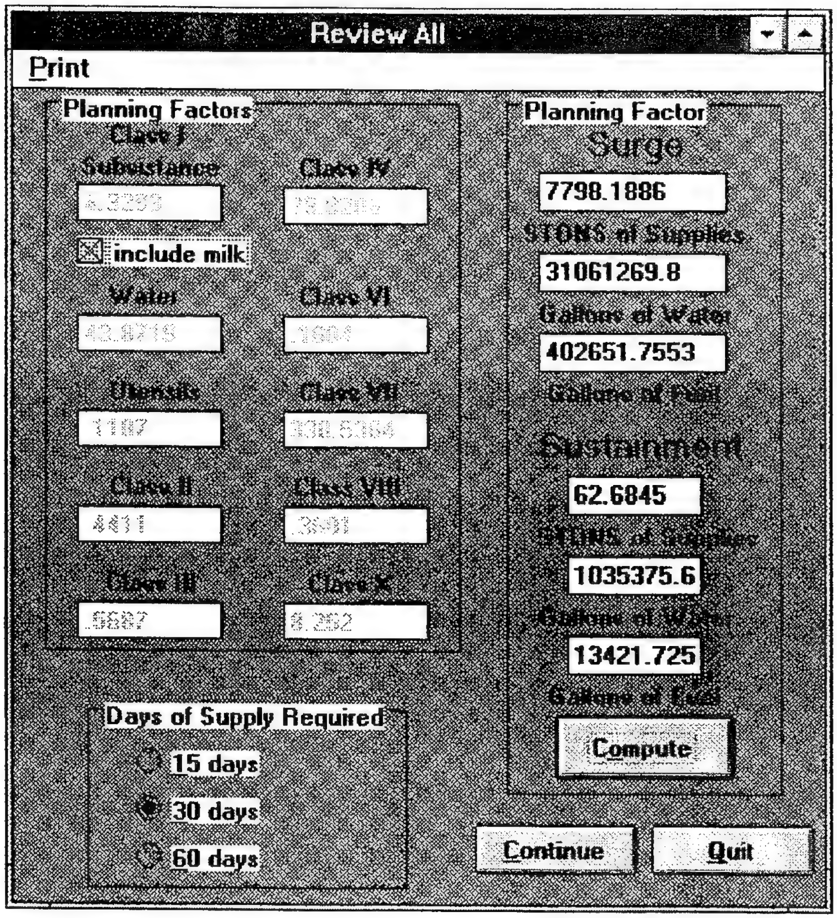


Figure 5.23. HOPS Review All Screen

C. CHAPTER SUMMARY

The purpose of this chapter was to walk the user through the Humanitarian Operations Planning System. Each of user screens included in the program were discussed as well as inputs required by the user and techniques to transverse the various

screens. In addition, the visual snapshot of each of the screens amplified the derivation of the planning factors for Operation Sea Signal described in the previous chapter. After reading this chapter, the planner should be able to transverse the various screens with minimal effort. The end result is a very quick analysis of the materials required to support a population during a humanitarian operation and this should also aid in transportation planning.

VI. CONCLUDING REMARKS

A. SUMMARY

This thesis has built a foundation for planners who are preparing to support humanitarian operations. Specifically, a structure has been defined which will enable planners to accurately classify and identify the major factors affecting the materials required to support the victims of a disaster. Moreover, using the structure this thesis has developed logistics planning factors relating to the support of the victims. Except for Class V, ammunition, and Class IX, repair parts, each class of supply was reviewed and an associated logistics planning factor was developed using a three-step process.

The first step entailed determining the actual requirements for each class of supply. The requirements were derived from historical studies of past operations, the Service's requirements, and argumentative reasoning. The second step involved quantifying the requirements. During this step, the requirements were converted into usable logistics quantities like pounds or gallons. In many cases, untraditional methods were used. For instance, several manufacturers for a product were contacted and the established weight of a product was computed as average of the various manufacturer's product weights. Unfortunately, not all classes of supply could be accurately quantified. When quantifying the requirements was not possible, the requirements were estimated by varying the Service's current planning factors to address the situation at hand based on the quantities that were known. The final step was to convert the quantities into a usable logistics planning factor. This was accomplished by analyzing the lifecycles and replenishment rates of the various commodities. The end result was planning factors that corresponded to the Service's current planning factors in that they are both measured in pounds per person.

To facilitate the use of the derived planning factors, a computer assisted planning tool was derived. The program, known as the Humanitarian Operations Planning System,

allows the user to input the appropriate variables and select the items that are to be distributed. Then, the program outputs the appropriate logistics planning factors. The planner does not need to know the mathematics to calculate the planning factors and the calculation can be completed in minutes. More importantly, the program can quickly aggregate the requirements so that the planner can get a feel for the quantity and types of transportation required to bring the materials into the theater of operations.

The derived planning factors were compared to the actual consumption rates experienced during Operation Sea Signal in Guantanamo Bay, Cuba. The majority of the data available proved to be unsuitable for comparison. This was not much of a surprise because the lack of accurate data was one of the motivating factors of this thesis. However, when the data was comparable, there was a remarkable correlation between the derived planning factors and the actual consumption rates. For the remaining classes of supply, all that can be said is the model appears to account for the majority of the items used in the operation or allows the planner to add to the model's built-in provisions. Since the planning factors are designed to assist the planners begin the planning process, not to dictate the planning requirements, it is believed the model will prove to be quite helpful to the planner in the initial stages of the planning process. This is because humanitarian operations are often short-fused and offer very little guidance on the material requirements necessary to support the victims. The model lays the groundwork from which the planner can begin the planning process for the material support of humanitarian operations.

B. RECOMMENDATIONS FOR FUTURE STUDY

Recommendations that directly build on this thesis include: developing a tracking system that can be used by the JTF in-theater, a more detailed analysis of the Class IV requirements, further validation of the planning factors described within, and expanding the existing structure to accommodate additional variables. As noted when attempting to validate the planning factors that were derived, the tracking of supplies for these operations is very poor. Unfortunately, the problem does not appear to be improving, but

the problem is rapidly gaining attention of senior logisticians. The senior logisticians are interested in accurate tracking of supplies to reduce the number of shipments, or large portions of shipments, being "misplaced" due to poor tracking. Moreover, validation of the planning factors to support humanitarian operations hinge on accurate and timely data collection. This thesis was unable to accurately quantify the Class IV requirements so any effort to update the base line planning factors to reflect the actual usage rate would greatly improve the model. Finally, exploring additional variables has the potential to further focus the planning factors on the situation at hand.

There are many areas that still need to be explored when considering the logistics involved in supporting humanitarian operations. This thesis has only explored one aspect of material consumption. That is, the consumption of supplies by the recipient population. No consideration was given to supplying the troops, moving the required supplies into the theater of operations, prepositioning the necessary supplies in the various hot spots, or determining the optimal force and force mix allocations to support humanitarian operations. The results from research on any of the aforementioned topics would be beneficial to the decision makers as well as establish a baseline for supporting budgetary decisions regarding funding for these operations in the future.

APPENDIX A. RECIPIENTS OF U.S. GOVERNMENT ASSISTANCE 1964-1992[1]

Table only contain countries that have received aid more than five times.

Country	Occurrences	Country	Occurrences
Afghanistan	5	Liberia	5
Algeria	8	Laos	6
Austria	6	Madagascar	8
Bangladesh	13*	Malaysia	6
Benin	6	Mali	9
Bolivia	15	Mauritania	7
Botswana	6	Mauritius	7
Brazil	21	Mexico	6
Burkina Faso	11	Morocco	7
Burma	12	Nepal	11
Chad	8	Nicaragua	16
Chile	10	Niger	11
Colombia	12	Pakistan	9
Costa Rica	10	Panama	10
Cyprus	5	Paraguay	6
Djibouti	6	Peru	18
Dominica Republic	7	Philippines	17
Ecuador	15	Portugal	6
El Salvador	10	Senegal	11
Ethiopia	12	Somalia	6*
Fiji	9	Sri Lanka	10
French Caribbean	5	Sudan	9*
Gambia	6	Tanzania	5
Greece	6	Thailand	8
Guatemala	9	Togo	5
Haiti	12*	Tunisia	6
Honduras	10	Turkey	12
India	24	Uganda	6
Indonesia	20	Vietnam	6
Italy	8	Yemen Arab Republic	5
Jamaica	6	Yugoslavia	7
Kenya	6	Zaire	8
Korea, Rep.	12	Zambia	5
Lebanon	8		

** Countries currently considered as possible contingency areas*

[1] After: Ref. 47: p. 67

APPENDIX B. STANDARD HEIGHT/WEIGHT TABLES

The following tables are adaptations of references 26, 27 ,28. The first table is for adults, the second table is for children and the final table is for infants. Because children grow at different rates, there may be cases when a child has outgrown his chart. When this occurs, the child will be assessed using the table for adults but the normal weight range for the child height is extended to include 85% to 120% of the standard weight.

	Weight			
Height	Women	Normal Range	Men	Normal Range
58	116	104 - 128		
59	118	106 - 130		
60	120	108 - 132	126	113 - 139
61	122	110 - 134	128	115 - 141
62	124	112 - 136	130	117 - 143
63	127	114 - 140	133	120 - 146
64	131	118 - 144	137	123 - 151
65	134	121 - 147	140	126 - 154
66	138	124 - 152	144	130 - 158
67	142	128 - 156	148	133 - 163
68	146	131 - 161	152	137 - 167
69	150	135 - 165	156	140 - 172
70	154	139 - 169	161	145 - 177
71	157	141 - 173	166	149 - 183
72	161	145 - 177	172	155 - 189
73			178	160 - 196
74			184	166 - 202
75			190	171 - 209
76			196	176 - 216

Table B.1. Standard Height/Weight Chart for Individuals Age 16 and Over.

Height	Weight	Normal Range
36	28	24 - 32
38	32	27 - 37
40	35	30 - 40
42	38	32 - 44
44	42	36 - 48
46	45	38 - 54
48	49	42 - 59
50	55	47 - 66
52	63	54 - 76
54	70	60 - 84
56	75	64 - 90
58	82	70 - 98
60	90	81 - 108
62	100	90 - 120
64	110	99 - 132

Table B.2. Standard Height/Weight Chart for Children Ages 3 to 16.

Height	Weight	Normal Range
20	7.5	6-10
22	10	8-12
24	13	11-15
26	16	13-18
28	19	16-22
30	22	19-25
32	24	21-29
34	26	23-30
36	28	24-32

Table B.3. Standard Height/Weight Chart for Children Ages 0 to 3.

APPENDIX C. RECOMMENDED DAILY DIETARY ALLOWANCES[1]

Category	Calories	Protein	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Niacin	Ascorbic Acid	Vitamin D
Men		*grams*	*grams*	*mg.*	*I.U.*	*mg.*	*mg.*	*mg.*	*mg.*	*I.U.*
Sedentary	2500	70	0.8	12	5000	1.2	1.6	12	75	n/a
Moderately Active	3000	70	0.8	12	5000	1.5	2	15	75	n/a
Very Active	4500	70	0.8	12	5000	2	2.6	20	75	n/a
boys										
13 -15	3200	85	1.4	15	5000	1.5	2	15	90	400
16 -20	3800	100	1.4	15	6000	1.8	2.5	18	100	400
Women										
Sedentary	2100	60	0.8	12	5000	1.1	1.5	11	70	n/a
Moderately Active	2500	60	0.8	12	5000	1.2	1.6	12	70	n/a
Very Active	3000	60	0.8	12	5000	1.5	2	15	70	n/a
Pregnant	300+	85	1.5	15	6000	1.8	2.5	18	100	400-800
Lactating	500+	100	2	15	8000	2	3	20	150	400-800
girls										
13 -15	2600	80	1.3	15	5000	1.3	2	13	80	400
16 -20	2400	75	1	15	5000	1.2	1.8	12	80	400
Children										
Under 1	100/Kg.	3.5/Kg.	1	6	1500	0.4	0.6	4	30	400-800
1 to 3	1200	40	1	7	2000	0.6	0.9	6	35	400
4 to 6	1600	50	1	8	2500	0.8	1.2	8	50	400
7 to 9	2000	60	1	10	3500	1	1.5	10	60	400
10 to 12	2500	70	1.2	12	4500	1.2	1.8	12	75	400

[1] After: Ref. 26: p. 515

APPENDIX D. CALORIES PER POUND OF BODY WEIGHT

The following table provides multipliers for the various demographic groups. The multipliers are used in conjunction with the mean body weight for the demographic group in question to compute the estimated calories required by the group to sustain normal body function. Also included in this appendix are two applications of the table.

Category	Calories per pound[1]	Calories per pound[2]
Men		
Sedentary	16.234	16
Light		16.883
Moderately Active	19.481	21
Very Active	29.221	26
boys 15 - 18		19
Women		
Sedentary	16.406	14
Light		15.625
Moderately Active	19.531	18
Very Active	23.438	22
girls 13 - 18		35 - (1.1 x age in years)
Children		
Under 1	45	
boys 1 to 14		45 - (1.4 x age in years)
girls 1 to 12		45 - (1.4 x age in years)

[1] **Calculated directly from Recommended Daily Dietary Allowances**
[2] **Numbers or equations extracted from References 26, 27, and 28**

Application A
Sample population: male
Activity level: Light
Multiplier: 19
Average weight: 160
Calories required per person:
160 x 19 = 3040

Application B
Sample Population: girls, age 15
Activity level: moderate
Multiplier: 35 - (1.1 X age in years)
Average weight: 105
Calories required per person:
105 x (35 - (1.1 x 15)) = 2047.5

APPENDIX E. FAMILY FOOD PLAN[1]

This table was adapted from Doctor Sherman's book *Chemistry of Food and Nutrition*. It presents nutritional guidance in a non-technical way. The data from this chart is the basis for further analysis regarding the relationship between calories per person and pounds per person.

Category	Calories	Milk Products	Fruits and Vegetables	Meat, Poultry, Fish	Flour, Cereals	Fats and Sugars
Men		*qt.*	*oz.*	*oz.*	*oz.*	*oz.*
Sedentary	2500	.71	19.4	6	8	3.42
Moderately Active	3000	.71	21.71	6.85	10.85	4
Very Active	4500	.85	28.57	7.42	20.57	5.42
boys						
13 -15	3200	.85	24.57	6.42	11.42	4.28
16 -20	3800	.85	26.85	7	16	4.85
Women						
Sedentary	2100	.64	17.14	5.71	5.71	3.42
Moderately Active	2500	.64	19.4	6	8	3.42
Very Active	3000	.79	21.71	6.85	10.85	4
Pregnant	300+	1	19.4	7	6.85	3.14
Lactating	500+	1.5	30.85	7	6.85	3.14
girls						
13 -15	2600	.85	18.85	5.85	9.14	3.42
16 -20	2400	.71	17.71	5.85	8	3.14
Children						
Under 1	45/lb.	1	10.28	1	1.14	.28
1 to 3	1200	.71	12	1.85	3.42	.85
4 to 6	1600	.71	13.71	3.28	4.57	2
7 to 9	2000	.71	18.28	4.42	5.71	2.57
10 to 12	2500	.85	19.4	5.57	7.42	3.14

[1] After: Ref. 26: p.515

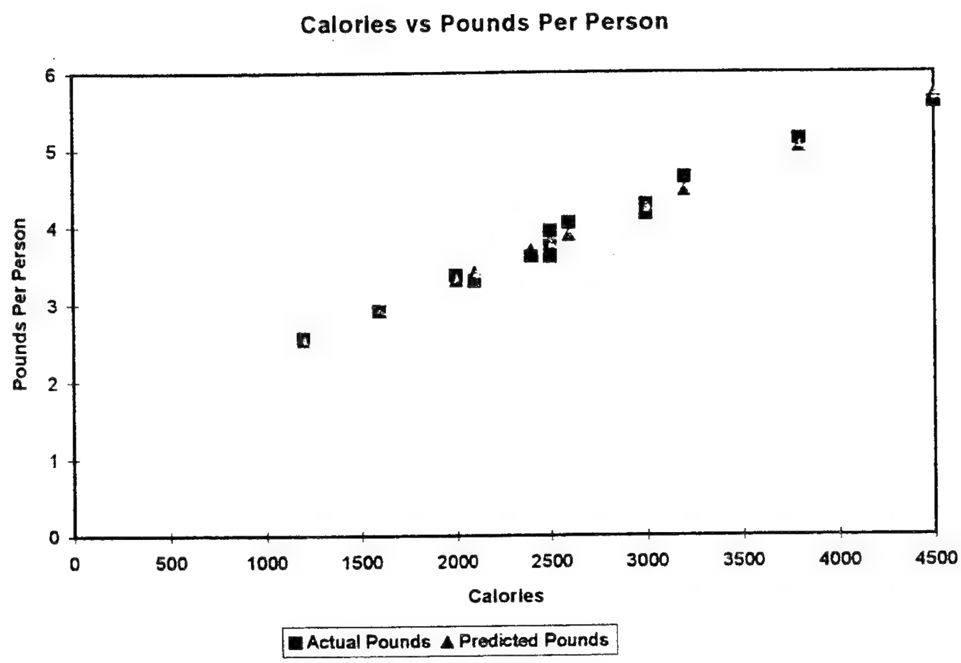
APPENDIX F. RESULTS OF LINEAR REGRESSION INCLUDING MILK PRODUCTS

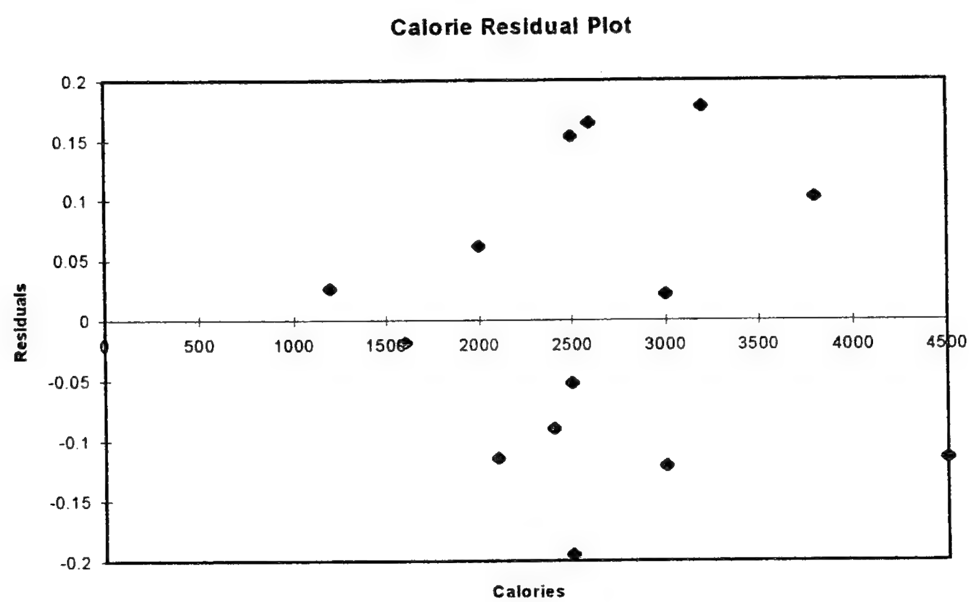
Analysis conducted using Microsoft Excel and AGSS, an IBM product

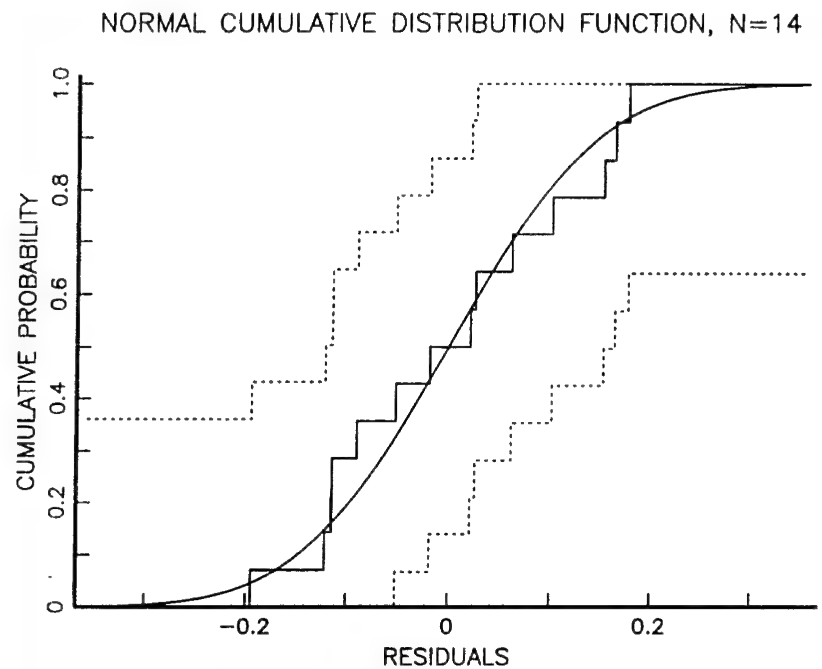
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.38439774	0.112835618	12.26915553	3.776E-08	1.13855006	1.6302454
X Variable 1	0.00095995	4.08894E-05	23.47661582	2.131E-11	0.00087086	0.001049

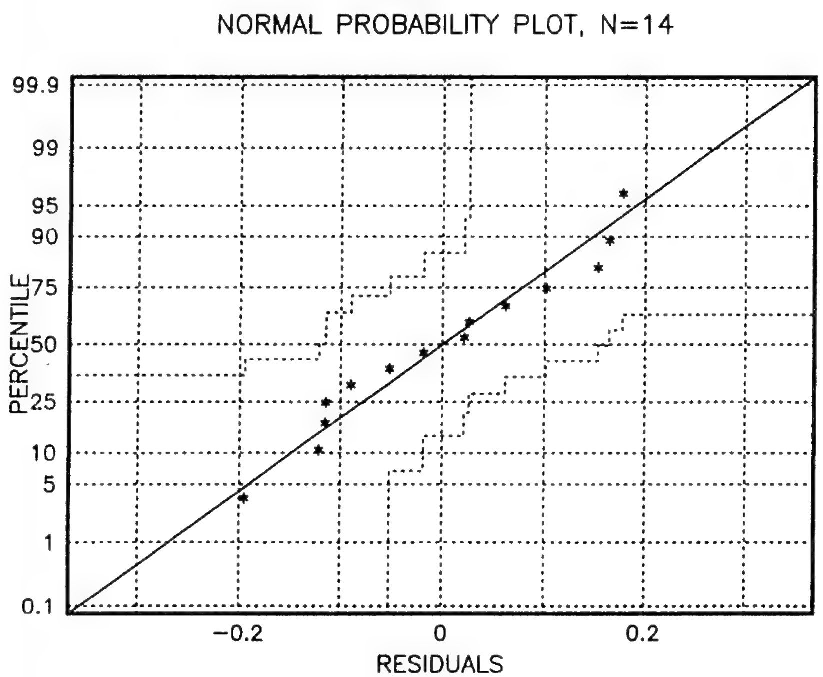
Regression Statistics	
Multiple R	0.9892883
R Square	0.97869135
Adjusted R Square	0.97691563
Standard Error	0.12504514
Observations	14

Observation	Predicted Y	Residuals	Standard Residuals
1	2.5363328	0.026167199	0.209262024
2	2.92031115	-0.018525439	-0.148150009
3	3.30428951	0.061781923	0.494076954
4	3.40028409	-0.114569808	-0.916227586
5	3.68826786	-0.090053573	-0.720168506
6	3.78426245	0.153237553	1.225457873
7	3.78426245	-0.194976732	-1.559250762
8	3.78426245	-0.05211959	-0.416806194
9	3.88025703	0.164385822	1.314611829
10	4.26423539	-0.121378245	-0.970675414
11	4.26423539	0.021478898	0.171769154
12	4.45622456	0.177704008	1.421118848
13	5.03219209	0.101736479	0.813598012
14	5.70415421	-0.114868496	-0.918616223


Calories vs Pounds Per Person
Pounds Per Person
6
5
4
3
2
1
0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Calories
Actual Pounds
Predicted Pounds


Calorie Residual Plot
Residuals
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
500
1000
1500
2000
2500
3000
3500
4000
4500
Calories





ANALYSIS OF NORMAL DISTRIBUTION FIT

DATA	:	ERROR1
SELECTION	:	ALL
X AXIS LABEL	:	RESIDUALS
SAMPLE SIZE	:	14
CENSORING	:	NONE
FREQUENCIES	:	1
EST. METHOD	:	MAXIMUM LIKELIHOOD
CONF METHOD	:	EXACT

PARAMETER	ESTIMATE	CONF. INTERVALS (95 PERCENT) LOWER	UPPER
MU	-7.1429E-6	-0.069371	0.069357
SIGMA	1.1576E-1	0.087088	0.19355

LOG LIKELIHOOD FUNCTION AT MLE = 10.322

COVARIANCE MATRIX OF PARAMETER ESTIMATES

MU	SIGMA
0.00095718	0
0	0.00047859

	SAMPLE	FITTED
MEAN :	-7.1429E-6	-7.1429E-6
STD DEV :	1.2013E-1	1.1576E-1
SKEWNESS:	8.6341E-2	0.0000E0
KURTOSIS:	1.7824E0	3.0000E0

* BASED ON MIDPOINTS OF FINITE INTERVALS

PERCENTILES	SAMPLE	FITTED
5:	-0.1949	-1.9046E-1
10:	-0.1214	-1.4838E-1
25:	-0.1146	-7.8052E-2
50:	0.0015	-7.1312E-6
75:	0.1017	7.8037E-2
90:	0.1644	1.4837E-1
95:	0.1777	1.9044E-1

GOODNESS OF FIT TESTS

CHI-SQUARE	:	1.1361
DEG FREED	:	1
SIGNIF	:	0.28648
KOLM-SMIRN	:	0.13894
SIGNIF	:	0.94981
CRAMER-V M	:	0.046636
SIGNIF	:	> .15
ANDER-DARL	:	0.33626
SIGNIF	:	> .15

KS, AD, AND CV SIGNIF. LEVELS NOT EXACT WITH ESTIMATED PARAMETERS.

NOTE: A SMALL SIGNIFICANCE LEVEL (EG. P≤.01) INDICATES LACK OF FIT

CHI-SQUARE GOODIESS OF FIT TABLE

LOWER	UPPER	OBS	EXP	O-E	((O-E)*2)÷E
-INF.	-0.07452	5	3.6385	1.3615	0.50948
-0.07452	0	2	3.3619	-1.3619	0.55168
0	0.07452	3	3.3617	-0.36174	0.038925
0.07452	+INF.	4	3.6379	0.36208	0.036038
TOTAL		14	14		1.1361

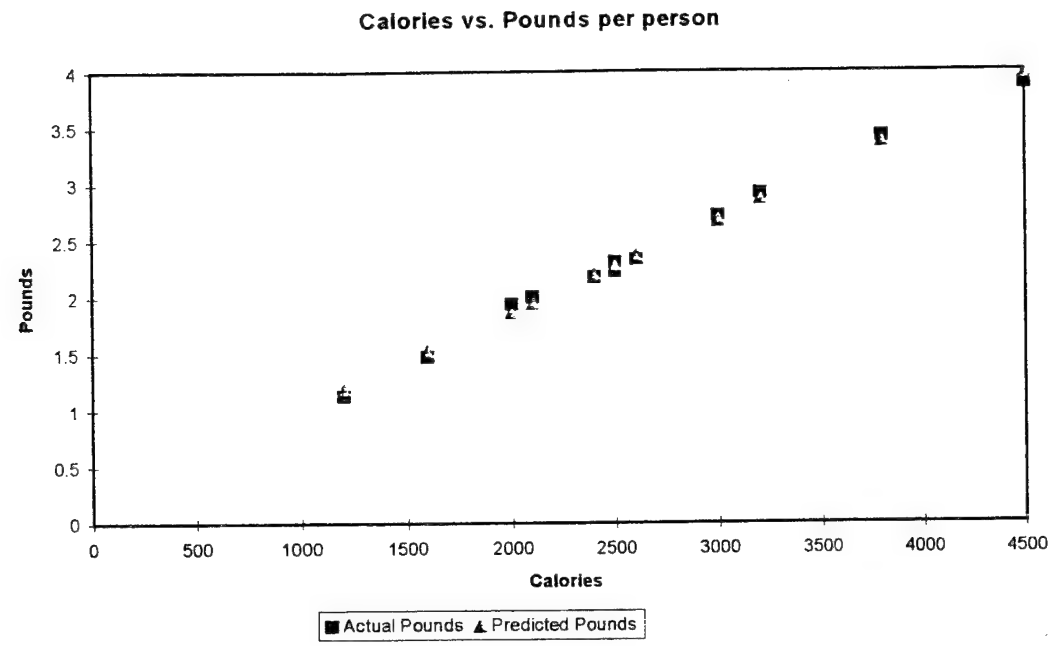
APPENDIX G. RESULTS FROM LINEAR REGRESSION EXCLUDING MILK PRODUCTS

Analysis conducted using Microsoft Excel and AGSS, an IBM product

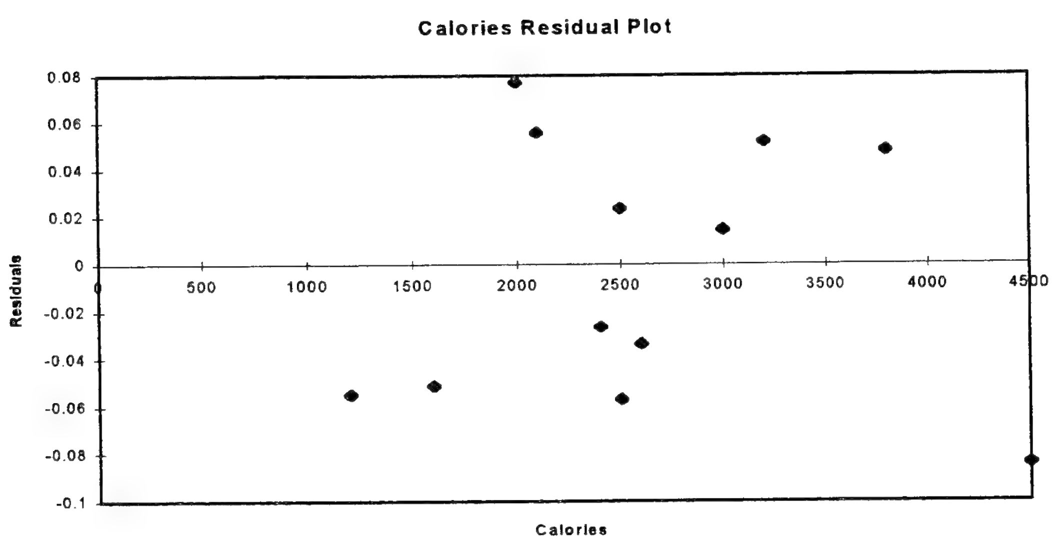
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.1811921	0.047588765	3.807455488	0.0024957	0.077505094	0.284879113
X Variable	0.0008396	1.72452E-05	48.68575817	3.693E-15	0.000802024	0.000877172

Regression Statistics	
Multiple R	0.99747825
R Square	0.99496286
Adjusted R Square	0.9945431
Standard Error	0.05273817
Observations	14

Observation	Predicted Y	Residuals	Standard Residuals
1	1.18870975	-0.054781181	-1.038738776
2	1.52454897	-0.051334683	-0.973387661
3	1.86038818	0.077111815	1.462163314
4	1.94434799	0.055652011	1.055251118
5	2.1962274	-0.026584544	-0.504085451
6	2.2801872	-0.056972919	-1.080297637
7	2.2801872	0.023384224	0.443402273
8	2.2801872	0.023384224	0.443402273
9	2.36414701	-0.033789866	-0.640709883
10	2.69998622	0.014299489	0.271141182
11	2.67	0.014299489	0.271141182
12	2.86790583	0.051737024	0.981016699
13	3.37166466	0.0479782	0.909743382
14	3.95938329	-0.084383286	-1.600042012

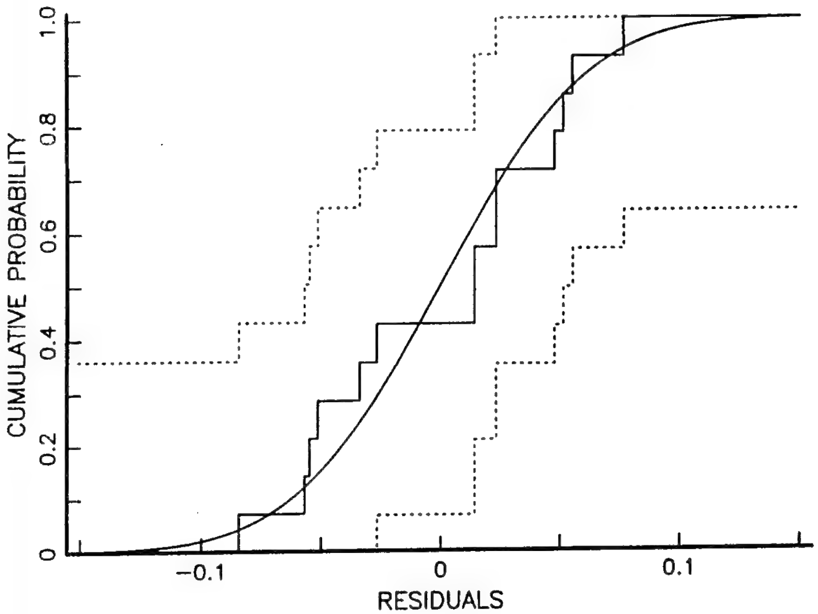


Calories vs. Pounds per person
Pounds
Calories
Actual Pounds
Predicted Pounds

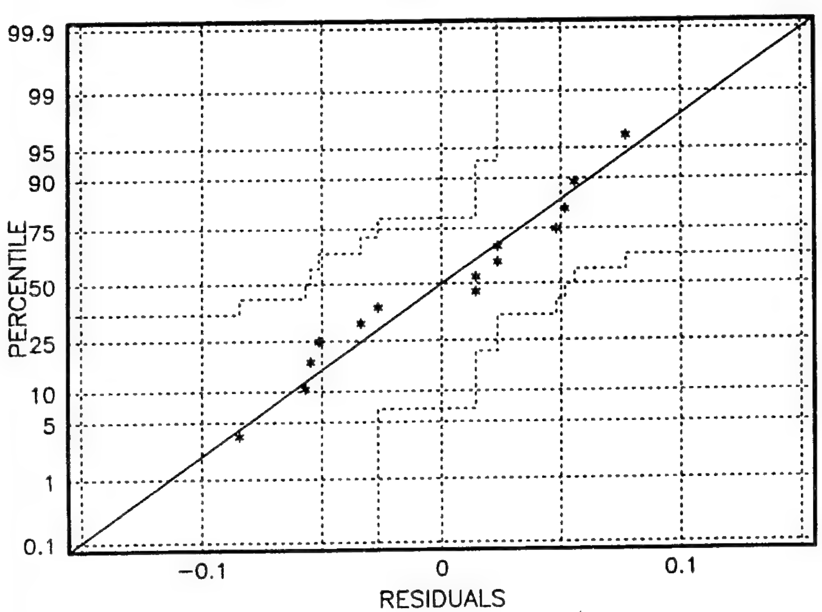


Calories Residual Plot
Residuals
Calories

NORMAL CUMULATIVE DISTRIBUTION FUNCTION, N=14



NORMAL PROBABILITY PLOT, N=14



ANALYSIS OF NORMAL DISTRIBUTION FIT

DATA	:	ERROR2
SELECTION	:	ALL
X AXIS LABEL	:	RESIDUALS
SAMPLE SIZE	:	14
CENSORING	:	NONE
FREQUENCIES	:	1
EST. METHOD	:	MAXIMUM LIKELIHOOD
CONF METHOD	:	EXACT

		CONF. INTERVALS (95 PERCENT)	
PARAMETER	ESTIMATE	LOWER	UPPER
MU	-2.4782E-19	-0.029261	0.029261
SIGMA	4.8833E-2	0.036738	0.081649

LOG LIKELIHOOD FUNCTION AT MLE = 22.406

COVARIANCE MATRIX OF PARAMETER ESTIMATES

MU	SIGMA
0.00017033	0
0	0.000085166

	SAMPLE	FITTED
MEAN :	-2.4782E-19	-2.4782E-19
STD DEV :	5.0676E-2	4.8833E-2
SKEWNESS:	-1.4233E-1	0.0000E0
KURTOSIS:	1.7227E0	3.0000E0

* BASED ON MIDPOINTS OF FINITE INTERVALS

PERCENTILES	SAMPLE	FITTED
5:	-0.0844	-8.0340E-2
10:	-0.057	-6.2590E-2
25:	-0.0513	-3.2923E-2
50:	0.0143	4.9324E-9
75:	0.048	3.2923E-2
90:	0.0557	6.2590E-2
95:	0.0771	8.0340E-2

GOODNESS OF FIT TESTS

CHI-SQUARE	:	2.4618
DEG FREED	:	1
SIGNIF	:	0.11665
KOLM-SMIRN	:	0.18661
SIGNIF	:	0.71421
CRAMER-V M	:	0.07967
SIGNIF	:	> .15
ANDER-DARL	:	0.44607
SIGNIF	:	> .15

KS, AD, AND CV SIGNIF. LEVELS NOT EXACT WITH ESTIMATED PARAMETERS.

NOTE: A SMALL SIGNIFICANCE LEVEL (EG. P≤.01) INDICATES LACK OF FIT

CHI-SQUARE GOODNESS OF FIT TABLE

LOWER	UPPER	OBS	EXP	O-E	((O-E)*2)÷E
-INF.	-0.0323	5	3.5583	1.4417	0.58412
-0.0323	0	1	3.4417	-2.4417	1.7323
0	0.0323	4	3.4417	0.55831	0.090568
0.0323	+INF.	4	3.5583	0.44169	0.054827
TOTAL		14	14		2.4618

APPENDIX H. SUMMARY OF DERIVED PLANNING FACTORS

CLASS I. Subsistence

Calories Required	Pounds per person per day with milk	Pounds per person per day w/o milk[1]
1500	2.82	1.43
1600	2.92	1.51
1700	3.02	1.59
1800	3.11	1.68
1900	3.21	1.76
2000	3.30	1.84
2100	3.40	1.92
2200	3.50	2.01
2300	3.59	2.09
2400	3.69	2.17
2500	3.78	2.26
2600	3.88	2.34
2700	3.98	2.42
2800	4.07	2.51
2900	4.17	2.59
3000	4.26	2.67

[1] Milk requirements are .71 quarts per person per day. Boys and very active men require .85 quarts per day. Infants and Pregnant women-1 quarts per day. Lactating women- 1.5 quarts per day.

Table H.1. Logistics Planning Factors for Subsistence

Water Requirements (Gallons Per Person Per Day)

	Climate				
Use	Arctic	Cold	Temperate	Tropical	Desert
Drinking	.325-.725	.325-.725	.40-.90	.5-1.2	.65-1.5
Hygiene	1-19.2	1-19.2	1-36.7	1-36.7	1-36.7
Laundry	2.5	2.5	2.5	2.5	2.5
Food Preparation	0-4.5	0-4.5	0-4.5	0-4.5	0-4.5
Medical	.358	.358	.358	.358	.558
Waste	.4-2.7	.4-2.7	.4-4.5	.4-4.7	.4-4.7

Table H.2. Logistics Planning Factors for Water Consumption

The following tables explain the water uses with ranges in more detail. The charts are developed for a temperate climate.

Category	Minimum Gallons per person per day	Standard Gallons[1] per person per day
Infants	0.325	0.40
Males	0.725	0.90
Females	0.525	0.65
Pregnancy	0.600	0.75
Lactation	0.650	0.80

[1] This value is calculated by adding ten percent to the minimum factor

Table H.3. Logistics Planning Factors for Drinking Water

Meal	Gallons per person per meal
MRE	.25
Kitchen Prepared	1.5[1]

[1] Includes a factor of .25 gallons per person for kitchen sanitation

Table H.4. Logistics Planning Factors for Water Used in Food Preparations

Category	Minimum	1 shower per week	2 showers per week	3 showers per week	1 shower per day	2 showers per day
Males	1.7	4.2	6.7	9.2	19.2	36.7
Females	1	3.5	6	8.5	18.5	36

Table H.5. Logistics Planning Factors for Water Used for Personal Hygiene

Climate	Multiplicative Factor
Temperate	1.0
Tropical	1.3
Desert	1.6
Cold	0.8
Arctic	0.7

Table H.6. Climate Factors for Water Consumption

Utensils (Pounds per person per day)

Item	Pounds per Item
Plate	0.038
Napkins	0.005
Cups.	0.014
Forks	0.0165
Knives	0.0167
Spoon	0.0122

Table H.7. Logistics Planning Factors for Eating Utensils

Class II. Personal Supplies

Tents

		Planning Factor	
Tent	Total Weight	Surge	Daily
GP, Medium	455	37.92	0.104
GP, Medium w/Liner	545	45.42	0.124
Arctic	76	7.60	0.021

Table H.8. Logistics Planning Factors for Tent Requirements

Housekeeping Requirements

	Quantity	
Laundry Policy	Lbs per week	Lbs per day
none	0	0
1 load per week	0.5	0.071
2 loads per week	1	0.143

Table H.9. Logistics Planning Factors for Laundry Soap

Number issued	Planning Factor
1 per day	0.0625
1 every other day	0.0313
1 every three days	0.0208

Table H.10. Logistics Planning Factors for Trash Bags

Clothing

	Men		Women		Children		Infants	
Item	Weight	Factor	Weight	Factor	Weight	Factor	Weight	Factor
			Warm Climate Clothing					
shirts	0.500	0.008	0.400	0.007	0.300	0.005	0.100	0.002
shorts	0.500	0.008	0.450	0.008	0.400	0.007		
underwear	0.125	0.002	0.100	0.002	0.070	0.001		
bras			0.250	0.004				
socks	0.180	0.003	0.150	0.003	0.080	0.001	0.017	0.0003
sneakers	2.000	0.022	1.750	0.019	1.500	0.017	1.000	0.0111
flip-flops	0.400	0.007	0.300	0.005	0.200	0.003		
			Cold Climate Clothing					
shirt	1.200	0.020	1.000	0.017	0.600	0.010	0.500	0.0083
pants	1.200	0.020	1.000	0.017	0.600	0.010	0.500	0.0083
thermal	1.200	0.020	1.150	0.019	0.600	0.010	0.250	0.0042
socks	0.250	0.004	0.200	0.003	0.100	0.002	0.080	0.0013
jacket	4.000	0.011	3.500	0.010	2.800	0.008	1.750	0.0048
boots	4.500	0.025	4.000	0.022	3.000	0.017		
gloves	0.500	0.006	0.400	0.004	0.300	0.003	0.250	0.0028

Table H.11. Logistics Planning Factors for Clothing Requirements

Personal Equipment

Item	General		Infants	
	Weight	Factor	Weight	Factor
cot	10	0.0274	10	0.0274
blanket	2	0.0055	0.5	0.0014
sheets	1	0.0056	0.5	0.0028
pillow	1	0.0027	N/A	N/A
pillowcase	0.2	0.0011	N/A	N/A
bucket	0.8	0.0022	2	0.0055
towel	0.5	0.0028	0.4	0.0022
washcloth	0.063	0.0003	0.05	0.0003
rain poncho	0.6	0.0033	N/A	N/A

Table H.12. Logistics Planning Factors for Personal Equipment

Class III - POL

Bulk Requirements

Item	Usage Rate[1]	Gallons Per	Fuel Type
5-Ton Truck	0.1243	Mile	Diesel
6000 Lb. Rough Terrain Forklift	5	Hour	Diesel
Rough Terrain Container Handler	8.5	Hour	Diesel
1000 Gal. Water Transport	0.1243	Mile	Gas
1200 Gal. Fuel Transport	0.0932	Mile	Gas
Sanitation Trucks	0.1243	Mile	Gas
5 - Ton Wrecker	0.2237	Mile	Gas
Garbage Truck	.0621	Mile	Gas
ROWPU	9.4	Hour	Diesel
Refrigerated Container	1.09	Hour	Diesel
Generator	6	Hour	Diesel
Yukon Heater	.63	Hour	Gas
Cooking Equipment	.63	Hour	Gas

[1] [Ref. 29: pp. 2-20 - 2-52]

Table H.13. Logistics Planning Factors for Fuel Consumption

Packaged Requirements

Item	Pounds per person
Package POL	0.295

Table H.14. Logistics Planning Factors for Packaged Fuel Consumption

Class IV

Required Materials	Pounds per person
Barrier Supplies	56
Heating Supplies (Arctic Climates)	3.5
Heating Supplies	2.92
Restroom Supplies	10.4
Shower Supplies	3
Kitchen Supplies	6
Storage Supplies	402[1]
Medical Supplies (Cool Climates)	530[2]
Medical Supplies	525[2]

[1] Pounds per required tent [2] Pounds per hospital bed

Table H.15. Logistics Planning Factors for Construction Materials

Class VI

Item	Weight	Factor
	gms.	*lbs.*
toothpaste	132	0.0118
toothbrush	10	0.0030
shampoo	457.6	0.0321
deodorant	48	0.0063
soap	143	0.0253
shaving cream	228.8	0.0311
comb	10	0.0026
brush	85.8	0.0253
razor	5	0.0046
toilet paper	171.6	0.0438
feminine hygiene	343.2	0.0297

Table H.16. Logistics Planning Factors for Individual Hygiene Items

Category	Planning Factor
Infants	0.0921
Children	0.1186
Women	0.1774
Men	0.1606

Table H.17. General Logistics Planning Factors for Class VI

Class VII

Item	Item Weight	Capacity
5-Ton Truck	22000	6 STONS
6000 Lb. Rough Terrain Forklift	27100	120 STONS
Rough Terrain Container Handler	105120	50 Containers
1000 Gal. Water Transport	14500	1000 Gallons
1200 Gal. Fuel Transport	15000	1200 Gallons
Sanitation Truck	14500	1000 Gallons
5 - Ton Wrecker	34400	N/A
Garbage Truck	36000[1]	N/A
ROWPU	37960	60,000 Gallons
Refrigerated Container	4000	33040 Pounds
Generator	7540	60 KW

[1] Estimated weight

Table H.18. Logistics Planning Factors for Individual Hygiene Items

Class VIII

Medical Requirement	Level of Services	
	Full Services	No Services
Beds (per person)	0.02	0.001
Supplies (per person per day)	1.41	0.07
Infant Supplies (per infant per day)	0.75	0.75

Table H.19. Logistics Planning Factors for Class VIII

Class X

Item	Weight per issue	Resupply weight
radio and 4 batteries	1.49	0.008
writing materials	0.867	0028
playing cards	0.125	N/A
board games	1.2	N/A
Bible	2.6	N/A
hat	0.5	N/A
sunglasses	0.6	N/A
cigarettes and matches	0.139	0.005
baseball equipment	60.2	.16
basketball equipment	146.2	.35
soccer equipment	86	.37
sewing equipment and supplies	27.056 - 28.725	.035 - .09
craft supplies	6.184	.103
books	3	N/A
barber kit	12.5	N/A
pens	0.0203	0.00068
note pad	0.8473	0.02824
chalk board	0.1600	N/A
chalk	0.0149	0.00050
marker board	0.1600	N/A
marker	0.0042	0.00014
easel	0.1600	N/A
easel pad	0.0575	0.00192
school books	3.0000	N/A

Table H.20. Logistics Planning Factors for Class X Items

APPENDIX I. CONDENSED DATA FOR SUBSISTENCE CONSUMPTION, UTENSIL CONSUMPTION AND THE ASSOCIATED SUMMARY STATISTICS

	Breakfast		Lunch	Dinner		Total	
Date	Food	Utensils	MRE	Food	Utensils	Food	Utensils
3-Nov	2.428	0.077	1.470	1.181	0.077	5.079	0.155
4-Nov	1.057	0.066	1.470	1.468	0.083	3.995	0.149
7-Nov	0.587	0.043	1.470	1.227	0.080	3.285	0.123
22-Nov	0.879	0.089	1.470	1.670	0.061	4.018	0.150
23-Nov	1.210	0.030	1.470	1.669	0.061	4.349	0.090
24-Nov	1.040	0.057	1.470	1.303	0.061	3.813	0.118
25-Nov	0.890	0.064	1.470	1.629	0.046	3.988	0.110
26-Nov	0.942	0.022	1.470	1.822	0.063	4.234	0.085
27-Nov	0.960	0.089	1.470	1.869	0.057	4.299	0.146
28-Nov	0.956	0.036	1.470	1.684	0.075	4.111	0.111
29-Nov	1.511	0.087	1.470	1.214	0.039	4.195	0.126
30-Nov	1.920	0.059	1.470	1.505	0.056	4.895	0.115
1-Dec	1.188	0.063	1.470	1.631	0.061	4.289	0.124
2-Dec	1.510	0.086	1.470	1.614	0.108	4.594	0.194
3-Dec	0.890	0.061	1.470	1.611	0.064	3.972	0.126
4-Dec	1.006	0.069	1.470	1.602	0.081	4.078	0.150

Table I.1. Condensed Data for Cuban Subsistence Consumption and Utensil Utilization

Statistic	Value
Mean	4.19
Standard Error	0.10
Median	4.15
Standard Deviation	0.42
Sample Variance	0.18
Range	1.79
Minimum	3.28
Maximum	5.08
Sum	67.19
Count	16

Table I.2. Summary of Statistics for Cuban Subsistence Consumption

Statistic	Value
Mean	0.129
Standard Error	0.007
Median	0.125
Standard Deviation	0.027
Sample Variance	0.001
Range	0.109
Minimum	0.085
Maximum	0.194
Sum	2.071
Count	16

Table I.3. Summary of Statistics for Cuban Consumption of Eating Utensils

APPENDIX J. CONDENSED DATA FOR WATER CONSUMPTION AND ASSOCIATED SUMMARY STATISTICS

Date	Total Water Consumption	Water Consumed by Haitian Camps	Water Consumed by Cuban Camps	Total Population	Haitian Population	Cuban Population	Haitian Consumption (GPP)	Cuban Consumption (GPP)
10-Oct	671830	321325	350505	38996	11780	27216	27.28	12.88
11-Oct	1106132	232580	873552	40065	11281	28784	20.62	30.35
12-Oct	1266908	348270	918638	36987	10530	26457	33.07	34.72
13-Oct	1304465	329075	975390	36587	10530	26057	31.25	37.43
14-Oct	1407320	329075	1078245	36161	10531	25630	31.25	42.07
15-Oct	1304190	314915	989275	35747	10531	25216	29.90	39.23
16-Oct	1291520	224195	1067325	35364	10532	24832	21.29	42.98
17-Oct	1234175	301840	932335	35032	10533	24499	28.66	38.06
18-Oct	1018570	180875	837695	33757	9773	23984	18.51	34.93
19-Oct	1110685	232660	878025	33023	9260	23763	25.13	36.95
20-Oct	1162375	192590	969785	32732	8505	24227	22.64	40.03
24-Oct	3031181	143569	2887612	31510	7490	24020	19.17	120.22
25-Oct	868550	127030	741520	30550	6489	24061	19.58	30.82
26-Oct	1008740	115610	893130	29981	6033	23948	19.16	37.29
27-Oct	920040	111720	808320	29824	6033	23791	18.52	33.98
28-Oct	984345	88275	896070	29632	6034	23598	14.63	37.97
29-Oct	1094250	110010	984240	29850	6034	23816	18.23	41.33
30-Oct	1144075	134545	1009530	29886	6034	23852	22.30	42.32
31-Oct	1241925	136360	1105565	29453	6034	23419	22.60	47.21
1-Nov	1014800	95375	919425	29716	6034	23682	15.81	38.82
2-Nov	1233575	99235	1134340	29667	6035	23632	16.44	48.00
3-Nov	1256240	150640	1105600	29657	6035	23622	24.96	46.80
4-Nov	1190565	119280	1071285	29588	6000	23588	19.88	45.42
5-Nov	1078155	111620	966535	29628	6001	23627	18.60	40.91
6-Nov	1151235	143230	1008005	29717	6002	23715	23.86	42.50
7-Nov	1132750	74475	1058275	29499	6002	23497	12.41	45.04
8-Nov	1168590	85490	1083100	29532	6004	23528	14.24	46.03
9-Nov	1526940	69095	1457845	29400	6005	23395	11.51	62.31
10-Nov	935685	85405	850280	29402	6005	23397	14.22	36.34
11-Nov	955450	100040	855410	29314	6007	23307	16.65	36.70
12-Nov	885415	75600	809815	29311	6007	23304	12.59	34.75
13-Nov	893724	75060	818664	28362	6008	22354	12.49	36.62
14-Nov	1258236	42435	1215801	29398	6008	23390	7.06	51.98
15-Nov	1471870	69330	1402540	29375	6008	23367	11.54	60.02
16-Nov	1336695	74780	1261915	29271	6008	23263	12.45	54.25
17-Nov	1215305	76570	1138735	29041	6009	23032	12.74	49.44
18-Nov	1283595	77190	1206405	28564	6740	21824	11.45	55.28
21-Nov	800965	75360	725605	29125	5940	23185	12.69	31.30
22-Nov	3215595	84460	3131135	28907	5937	22970	14.23	136.31
23-Nov	1206005	87860	1118145	28902	5958	22944	14.75	48.73
24-Nov	386370	88940	297430	28900	5953	22947	14.94	12.96
25-Nov	413665	98280	315385	28866	5990	22876	16.41	13.79

Table J.1. Condensed Data for Water Consumption

Statistic	Value
Mean	44.17
Standard Error	3.37
Median	40.47
Standard Deviation	21.81
Sample Variance	475.60
Range	123.44
Minimum	12.88
Maximum	136.31
Sum	1855.09
Count	42

Table J.2. Summary of Statistics for Actual Cuban Water Consumption

Statistic	Value
Mean	18.71
Standard Error	0.97
Median	18.37
Standard Deviation	6.31
Sample Variance	39.76
Range	26.01
Minimum	7.06
Maximum	33.07
Sum	785.69
Count	42

Table J.3. Summary of Statistics for Actual Haitian Water Consumption

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